



ORIGINAL ARTICLE

Evaluation of Published Research on Osseodensification -A Bibliometric Study

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ARTICLE INFO

Article history:

Received 06-04-2025

Accepted 10-05-2025

Published 19-11-2025

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<https://doi.org/10.38138/JMDR/v11i2.25.16>

ABSTRACT

Osseodensification is a novel biomechanical technique for bone preparation in dental implant placement. The aim of this study was to analyze the bibliometric characteristics of research on osseodensification and evaluate its academic impact. A retrospective bibliometric analysis was conducted using data obtained from the Scopus, Web of Science, PubMed, ScienceDirect, and Cochrane Library databases. The search was performed on June 01, 2024, using the keywords “Versah” OR “Densah” OR “Osseodensification.” The search yielded 114 records from Scopus, 88 from Web of Science, 90 from PubMed, 54 from ScienceDirect, and 62 from the Cochrane Library. After applying inclusion and exclusion criteria and removing duplicates and irrelevant records (n=286), a total of 122 articles were selected for analysis. Bibliometric parameters, including publication year, citation count, publishing sources, leading contributing countries, institutions, authors, authorship patterns, and the characteristics of the top 10 most cited articles, were assessed. Data analysis was performed using Microsoft Excel (v.16, Redmond, Washington). A bibliometric analysis of 122 research articles on osseodensification published between 2016 and 2024 identified key trends in publication and citation impact. The United States was the leading contributor, followed by Brazil and Italy. The International Journal of Oral & Maxillofacial Implants (n=9) and Implant Dentistry (74.20 citations per article) emerged as the most influential journals. While the United States had the highest number of publications (n=46), Romania exhibited the highest citation impact per article (27.80 citations/article). Institutional collaborations, particularly between two institutions, correlated with higher citation counts. Most authors contributed to a single article, with an average of 4.79 authors per study. Rodrigo Neiva was the most prolific author. Notably, the top 10 most-cited articles accounted for nearly half (48.56%) of all citations. Osseodensification is an emerging technique in implant dentistry and has significant potential to enhance implant success rates.

Keywords: Bibliometric; Densah; Implant dentistry; Osseodensification; Versah

1 INTRODUCTION

Brånemark⁽¹⁾ introduced the concept of osseointegration, defining it as the direct contact between living bone and the surface of a load-bearing implant, revolutionizing the treatment of fully and partially edentulous patients^(1–5). Traditionally, implant site preparation involves conical or cylindrical drills that cut and remove bone to accommodate the implant⁽⁶⁾. One of the key factors influencing implant success is primary stability, which depends on implant geometry, type, surgical technique, and bone density^(7,8). Several techniques, including Resonance Frequency Anal-

ysis (RFA), Periotest, and insertion torque, are commonly used to assess implant stability and osseointegration^(9–11).

After tooth extraction, alveolar ridge dimensions reduce at the edentulous site^(12,13), often leading to insufficient bone for implant placement. To address this, various augmentation procedures, such as alveolar ridge augmentation, ridge splitting, and maxillary sinus elevation, have been developed to enhance alveolar bone volume either prior to or during implant placement^(5,14).

In 2013, Huwais S. introduced osseodensification (OD) as an alternative to conventional bone-subtractive drilling⁽⁷⁾. This technique aims to enhance bone density, bone vol-

ume percentage, and bone-to-implant contact, ultimately improving implant stability⁽¹²⁾. Using Densah burs, OD applies a controlled compression force during drilling, leveraging the viscoelastic and viscoplastic properties of bone. Compared to conventional subtractive drilling, OD can increase primary and secondary implant stability and enhance bone-implant contact (BIC) by up to three times⁽¹³⁾. Key advantages of OD include bone volume preservation, accelerated healing due to bone matrix protection, and improved integration through the autogenous bone graft matrix along the implant surface⁽¹³⁾. Unlike standard drilling methods, OD centrifugally compacts bone at the osteotomy site, making it particularly beneficial for sub-antral bone grafting, narrow crest expansion, post-extraction implants, and cases of poor bone density (type IV) in the posterior maxilla^(14–16).

Bibliometric analysis serves as a quantitative tool to assess and evaluate scientific research output^(17,18), offering insights into research trends and development^(19,20). For instance, Alqahtani et al. conducted a bibliometric analysis of periodontics research in Saudi Arabia, highlighting significant growth due to increased international collaboration, particularly with researchers from the United States⁽²¹⁾. However, to the best of our knowledge, no bibliometric study has yet assessed research performance in the field of OD. Therefore, this study aims to conduct a comprehensive bibliometric analysis of OD-related publications, identifying leading contributing countries, institutions, authors, authorship trends, and the characteristics of the most highly cited articles.

2 MATERIALS AND METHODS

2.1 Study Design and Ethical Approval

This study was conducted as a bibliometric network analysis. Since it involved publicly available data, it was exempt from institutional ethical committee approval.

2.2 Databases and Keywords

A quantitative bibliometric analysis was performed using datasets from Scopus, Web of Science, PubMed, ScienceDirect, and the Cochrane Library. The search was conducted on June 01, 2024, using the keywords "Versah OR Densah OR Osseodensification." The search yielded 114 articles from Scopus, 88 from Web of Science, 90 from PubMed, 54 from ScienceDirect, and 62 from the Cochrane Library. After applying exclusion criteria, 286 records were removed, leaving 122 articles for final analysis (Table 1).

2.3 Inclusion and Exclusion Criteria

The study included peer-reviewed scientific literature such as original research articles, review articles, and case reports related to "Versah OR Densah OR Osseodensification."

Papers were screened for relevance, while sources with limited citations, including conference abstracts, editorials, and letters to the editor, were excluded.

2.4 Analysis

Microsoft Excel (v.16) software (Redmond, Washington) was employed for the data analysis.

Table 1:

Identification	Documents identified PubMed = 90 records Cochrane = 62 records Scopus = 114 records Web of Science = 88 records ScienceDirect = 54 records
Screening	Inclusion / Exclusion criteria applied
Eligibility	Documents assessed for Eligibility based on full text availability (n=139)
Included	Highly relevant documents included in bibliometric analysis (n=122)

Variables of Interest:

This study examined key aspects such as the annual distribution of articles and citations, the most frequently used journals, the most productive countries and institutions, leading authors, authorship patterns, and the most highly cited articles.

3 RESULTS

A total of 122 articles, published between 2016 and May 2024, were analyzed. These articles accumulated 2,156 citations, with an average of 17.67 citations per article. Publications from 2016 had the highest citation rate (205.67 citations per article), while those from 2024 had the lowest citation impact.

The 122 selected articles were published across 66 different journals, with 41 journals featuring only a single publication each. The top 10 most frequently used journals are listed in Table 2. The highest number of articles (n=9) appeared in The International Journal of Oral & Maxillofacial Implants, followed by Applied Science. In terms of citation impact, articles published in Implant Dentistry had the highest average (74.20 citations per article), followed by The International Journal of Oral & Maxillofacial Implants (IJO&MI) with 41.33 citations per article.

Authors from 32 countries contributed to the 122 selected articles. Among them, 13 countries had authors contributing to a single article, while authors from four countries contributed to two articles each. The top 15 contributing countries collectively published between three and 46 articles, as detailed in.

The United States accounted for more than one-third of the total publications (n=46; 37.70%), followed by Brazil

(n=24; 19.67%) and India (n=23; 18.85%). In terms of citation impact, articles from Romania had the highest average (27.80 citations per article), followed by the United States (25.54), Brazil (24.33), and Italy (24.29).

A total of 195 institutions from 32 countries contributed to the 122 selected articles. Among them, 144 institutions (73.84%) published a single paper, while 33 institutions contributed two papers, and nine institutions published three papers.

Researchers from New York University produced the highest number of articles (n=13), followed by the University of Florida (n=10) and the University of Pennsylvania (n=7). In terms of citation impact, articles from the University of Minnesota had the highest average (75.00 citations per article).

Among the top 10 institutions, six universities were from the United States, followed by two from Brazil and one each from Iraq and Egypt. Additionally, private dental practitioners contributed to 14 articles, which collectively received 118 citations, averaging 8.43 citations per article.

Authors from a single institution contributed to 48 articles, which received 422 citations, averaging 8.79 citations per article. Collaboration between two institutions resulted in 25 articles, accumulating 686 citations, with a higher average of 27.44 citations per article. Articles authored by researchers from three institutions totaled 15, receiving 253 citations (16.86 citations per article). In contrast, 34 articles involved contributions from more than three institutions, gaining 771 citations, with an average of 22.64 citations per article. This suggests that collaboration between two institutions yielded the highest citation impact compared to other institutional collaboration patterns.

A total of 585 authors (including multiple contributions) were involved in the 122 articles, averaging 4.79 authors per article. The majority (n=389; 66.49%) contributed to a single article. Rodrigo Neiva (affiliated with the University of Florida and University of Pennsylvania) had the highest number of publications (n=14), followed by Paulo G. Coelho (n=11) and Nick M. Tovar (n=10).

Based on citation impact, Adham M. Aligarag (New York University & SUNY Upstate Medical University) and Estevam A. Bonfante (University of São Paulo) emerged as the most influential authors

The analysis of authorship patterns showed that only seven articles were authored by a single writer, while the majority (94.26%; n=115) were multi-author publications. The most common authorship patterns involved three and four authors, each contributing to 19 articles.

In terms of citation impact, articles with more than seven authors had the highest average (33.06 citations per article), followed by those with two authors (25.88 citations per article). In contrast, single-author articles had the lowest citation impact.

Nearly half of the total citations (n=1,047; 48.56%) were attributed to the top 10 most cited articles, with an average of 104.7 citations per article (Table 2). These articles were published between 2016 and 2021, with four articles from 2018 and three from 2016.

The top 10 articles appeared in seven different journals, with *Implant Dentistry* publishing the most (three articles), followed by *The International Journal of Oral & Maxillofacial Implants* with two articles.

Authors from seven countries contributed to these highly cited articles. The United States had the highest contribution (n=8 articles), followed by Brazil and India (two each), and one article each from Chile, Italy, Sweden, and Romania.

4 DISCUSSION

This study analyzed the evolution of osseodensification (OD) research over an eight-year period (2016–2024) using a bibliometric approach. Our findings reveal significant trends, with 2,156 citations accumulated across articles published between 2016 and May 2024, averaging 17.67 citations per article. The 2016 publications had the highest citation rate (205.67 citations per article), whereas 2024 publications had the lowest, likely due to the gradual increase in citation rates over time.

This study is particularly valuable as it provides insight into the progress of OD research, enhancing our understanding of its current role in implant dentistry. *The International Journal of Oral & Maxillofacial Implants* emerged as the most frequently used journal for OD research, while *Implant Dentistry* had the highest citation impact, followed by *The International Journal of Oral & Maxillofacial Implants*. This pattern suggests that OD research aligns well with the readership of these journals, making them preferred platforms for dissemination.

Despite the global nature of OD research, our findings highlight a notable concentration of research output in the United States, which contributed 37.70% of the analyzed articles, reaffirming its position as a leader in this field. Brazil (19.67%) and India (18.85%) followed closely behind. However, citation count alone does not fully reflect research influence, so we also examined citation impact. While the US produced the most articles, Romania had the highest average citations per article (27.80), followed by the US (25.54). This suggests that while the US is the most prolific contributor, research from other countries may be particularly impactful within the OD domain.

The dominance of US institutions is also evident, with six of the top 10 contributing institutions based in the United States. New York University, the University of Florida, and the University of Pennsylvania were the most active, while the University of Minnesota had the highest citation impact per article. Collaboration trends revealed that articles authored by researchers from two institutions had the highest citation impact, indicating that bilateral institutional

Table 2:

Serial No	Description of article	Total Citations
1	Huwais S, Meyer EG. A Novel Osseous Densification Approach in Implant Osteotomy Preparation to Increase Biomechanical Primary Stability, Bone Mineral Density, and Bone-to-Implant Contact. <i>Int J Oral Maxillofac Implants.</i> 2017 Jan/Feb;32(1):27-36.	251
2	Trisi P, Berardini M, Falco A, Podaliri Vulpiani M. New Osseodensification Implant Site Preparation Method to Increase Bone Density in Low-Density Bone: In Vivo Evaluation in Sheep. <i>Implant Dent.</i> 2016 Feb;25(1):24-31.	203
3	Lahens B, Neiva R, Tovar N, Alifarag AM, Jimbo R, Bonfante EA, Bowers MM, Cuppini M, Freitas H, Witek L, Coelho PG. Biomechanical and histologic basis of osseodensification drilling for endosteal implant placement in low density bone. An experimental study in sheep. <i>J Mech Behav Biomed Mater.</i> 2016 Oct;63:56-65.	163
4	Alifarag AM, Lopez CD, Neiva RF, Tovar N, Witek L, Coelho PG. Atemporal osseointegration: Early biomechanical stability through osseodensification. <i>J Orthop Res.</i> 2018 Sep;36(9):2516-2523	71
5	Huwais S, Mazor Z, Ioannou AL, Gluckman H, Neiva R. A Multicenter Retrospective Clinical Study with Up-to-5-Year Follow-up Utilizing a Method that Enhances Bone Density and Allows for Transcrestal Sinus Augmentation Through Compaction Grafting. <i>Int J Oral Maxillofac Implants.</i> 2018 Nov/Dec;33(6):1305-1311.	65
6	Pai UY, Rodrigues SJ, Talreja KS, Mundathaje M. Osseodensification - A novel approach in implant dentistry. <i>J Indian Prosthodont Soc.</i> 2018 Jul-Sep;18(3):196-200	62
7	Slete FB, Olin P, Prasad H. Histomorphometric Comparison of 3 Osteotomy Techniques. <i>Implant Dent.</i> 2018 Aug;27(4):424-428.	59
8	Padhye NM, Padhye AM, Bhatavadekar NB. Osseodensification – A systematic review and qualitative analysis of published literature. <i>J Oral Biol Craniofac Res.</i> 2020 Jan-Mar;10(1):375-380.	59
9	Koutouzis T, Huwais S, Hasan F, Trahan W, Waldrop T, Neiva R. Alveolar Ridge Expansion by Osseodensification-Mediated Plastic Deformation and Compaction Autografting: A Multicenter Retrospective Study. <i>Implant Dent.</i> 2019 Aug;28(4):349-355.	58
10	Bergamo ET, Zahoui A, Barrera RB, Huwais S, Coelho PG, Karateew ED, Bonfante EA. Osseodensification effect on implants primary and secondary stability: Multicenter controlled clinical trial. <i>Clin Implant Dent Relat Res.</i> 2021 Jun;23(3):317-28.	56

partnerships may enhance research visibility and influence.

Among individual researchers, Rodrigo Neiva (University of Florida & University of Pennsylvania) authored the highest number of articles, while Adham Aligarag (New York University & SUNY Upstate Medical University) and Estevam Bonfante (University of São Paulo) emerged as the most influential researchers based on citation impact. These findings underscore the leading role of US institutions while also recognizing the valuable contributions of both individual researchers and collaborative teams in advancing OD research.

The analysis of authorship patterns highlights the dominance of collaborative research, with only 7 out of 122 articles authored by a single researcher. This reinforces the importance of collaboration in academic publishing. While publications with three or four authors were the most common, articles with more than seven co-authors achieved the highest citation impact (33.06 citations per article). This suggests that larger research teams may facilitate more impactful knowledge exchange. Additionally, articles with two authors had a higher citation impact (25.88 citations

per article) compared to single-author papers, further emphasizing the value of co-authorship.

Citation analysis reveals that research impact is highly concentrated within a small group of influential articles. The top 10 most cited papers accounted for 48.56% of all citations, with an impressive average of 104.7 citations per article. These studies were published between 2016 and 2021, with the highest number (four articles) appearing in 2018, followed by three in 2016.

The geographic distribution of these influential articles demonstrates international collaboration, with authors from seven countries contributing. However, the United States led the field, contributing eight of the top 10 most cited articles, followed by Brazil and India, each with two articles. This trend underscores the global nature of impactful research, while also highlighting the prominence of US institutions.

Regarding publication venues, the top 10 most cited articles were spread across multiple journals. *Implant Dentistry* published the highest number (three articles), followed by *The International Journal of Oral & Maxillofacial Implants* with two articles, reinforcing their significance in

OD research.

4.1 Study Limitations

Despite the fact that this study provides valuable insights, this study has several limitations:

1. Keyword Selection Bias – The study relied on specific keywords for article identification, which may have led to the exclusion of relevant studies that used different terminology. Expanding the keyword selection in future research could provide a more comprehensive overview of OD literature.
2. Dataset Limitations – Articles were retrieved from Scopus, Web of Science, PubMed, ScienceDirect, and Cochrane Library. However, gray literature (e.g., conference papers, preprints, and dissertations) was not included, potentially omitting relevant findings. Future research should incorporate a broader range of data sources to enhance coverage.
3. Focus on Quantitative Analysis – This study primarily employed quantitative bibliometric methods, focusing on numerical data rather than assessing the methodological quality of individual studies. Future research should integrate qualitative assessments to evaluate the scientific rigor and clinical relevance of OD publications.

5 CONCLUSION

Osseodensification (OD) has emerged as a promising technique in implant dentistry, offering potential benefits for implant success. This bibliometric analysis reveals significant research growth in OD, driven by strong contributions from the United States and international collaborations. Further studies addressing research gaps, methodological quality, and a broader dataset will enhance our understanding of osseodensification's role in implant dentistry.

6 DISCLOSURE

Conflict of Interest: None.

Funding: None

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