

A study of dental implant complications through bibliometric analysis

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KEYWORDS

Bibliometrics,
Complications,
Dental Implant,
Implantology.

ABSTRACT:

Background: Dental implants are a widely successful solution for tooth replacement, yet complications remain a key challenge. Bibliometric analysis provides valuable insights into research trends, influential studies, and gaps in this field. This study examines the global literature to better understand advancements in addressing dental implant complications. **Objective:** To conduct a thorough bibliometric analysis of the scientific literature concerning complications associated with dental implants. **Methods:** The bibliometric study was performed in both French and English, focusing on a database search in Scopus using the keywords "dental implant complications" for articles published from 2013 to 2023. This analysis follows the PRISMA framework to synthesize research on dental implant complications and employs visualization software (VOSviewer) to highlight similarities among the studies. The selected studies were evaluated based on citation counts, with a cut-off date of October 19, 2024. **Results:** Over the past decade, publications addressing complications associated with dental implant systems have shown a clear upward trend. The journals contributing most significantly to this area of research are Clinical Oral Implants Research and the International Journal of Oral and Maxillofacial Implants. The University at Buffalo and the University of Napoli stand out as leading institutions in this field. Marco A.B. Esposito emerges as the most prolific author. The United States and Italy lead globally in publishing research on dental implant complications. **Conclusions:** The present study highlights a significant rise in literature addressing dental implant complications, demonstrated by an increasing number of publications, a wider range of contributors, and an expanded focus on various complications and influencing factors. This trend underscores the field's commitment to thoroughly understanding and tackling implant-related challenges, which holds the potential to improve implant longevity, enhance patient outcomes, and elevate the overall quality of care in dental implantology.

1. Introduction

Dental implants were popularized by Dr. Per-Ingvar Brånemark, a Swedish orthopedic surgeon and scientist, who revolutionized the field of dental implantology. His introduction of titanium-based endosseous implants and the discovery of osseointegration marked significant milestones in the discipline (Tjellström, 2015).

Today, dental implants are widely recognized as a reliable and effective solution for tooth replacement worldwide (Lang et al., 2019). Although dental implants exhibit high success and survival rates, a small percentage of cases still experience failure, highlighting the need for ongoing research and advancements in this field (French et al., 2021).

Years of research have provided valuable insights into the biomechanical properties of implant materials, failure modes, and associated complications. These complications typically occur either during the surgical phase or at the prosthetic stage (Gupta et al., 2015).

Indeed, complications associated with dental implants can be broadly categorized into biological issues, such as peri-implantitis and soft tissue inflammation, and mechanical problems, including implant fractures and prosthetic component failures (Hanif et al., 2017). The causes of these complications are multifactorial, involving patient-related factors, implant material properties, surgical technique, and postoperative care (Guruprasad et al., 2024).

Thus, with the increasing number of implants performed in general dental practice. It is crucial for dentists to be well-versed in both the art and science of managing complications related to implant prosthetics (Stanford, 2005). A comprehensive grasp of these complications is essential not only for improving clinical practices and patient outcomes but also for guiding future research in the field (Berglundh et al., 2002).

Furthermore, understanding the historical trends in dental implant complications through bibliometric analysis can help shape clinical guidelines and set priorities in dental education and practice (Joshi & Kandaswamy, 2024).

This bibliometric study aimed to evaluate the scientific literature on dental implant complications over the past decade 2013 to 2023 by analyzing the distribution of publications by year, journals, authors, countries, institutional contributions, science mapping, and researcher collaboration patterns. Ultimately, insights from these factors are critical for guiding future research, informing clinical practices, and improving patient outcomes.

2. Methods

This review was carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to identify the most relevant studies on complications in the field of oral implantology. Bibliometric and visualization techniques were utilized in this study. Additionally, the research was conducted on October 19, 2024. The metadata collected was exported from the Scopus database to SciVal in CSV format.

The search utilized the Scopus database, initially identifying 8,388 articles based on the keywords: (dental AND implant AND complications).

The research covered the past decade 2013 to 2023 and included (SUBJAREA , "DENT") OR LIMIT-TO (SUBJAREA , "MEDI"). Finally, the inclusion criteria for the research were focused on studies specifically addressing dental implants and complications, only articles published in English or French and appearing as journal articles were considered. Exclusion criteria ruled out research outside these specified areas, publications from before 2013 or after 2023, articles in other languages, and works such as theses, conference papers, books, book chapters, and blogs. Then, after applying inclusion and exclusion criteria, 3,823 relevant articles were selected for the final review. In addition, the analytic research framework is illustrated in Fig. 1.

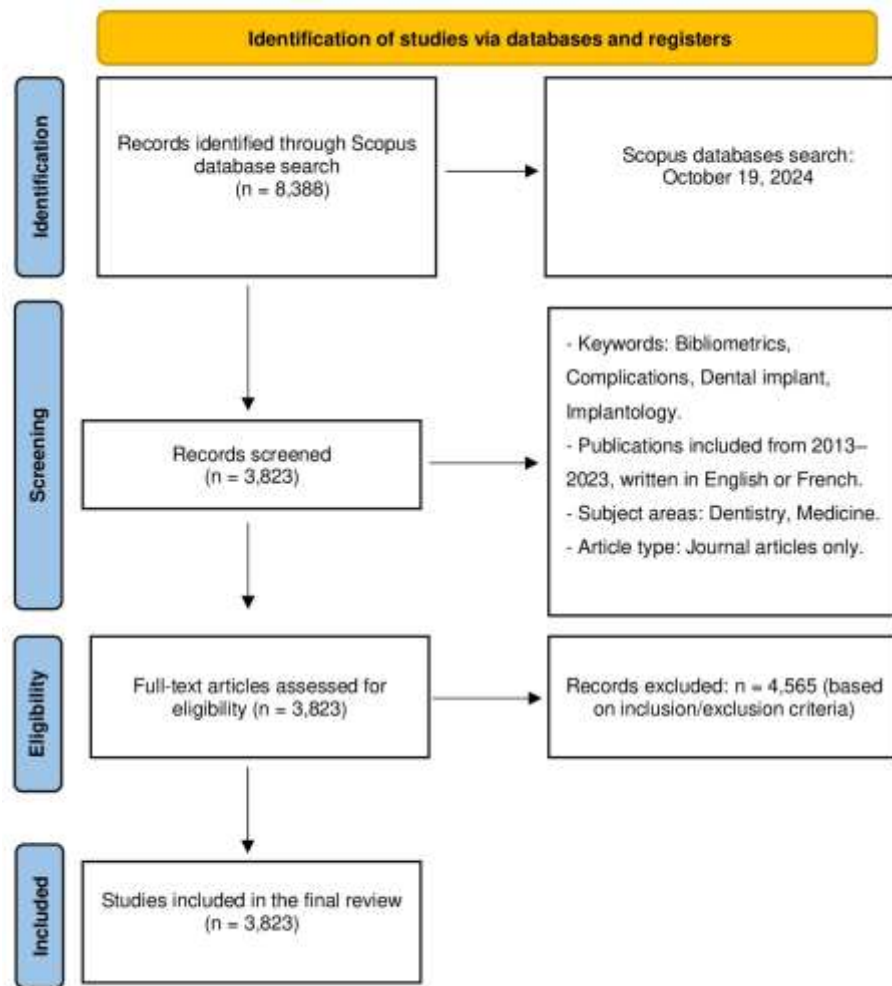


Fig. 1: Prisma framework of the study

3. Results

Between 2013 and 2023, there has been a clear upward trend in publications on complications related to dental implant systems, as shown by the data. Since 2013, when 243 publications were recorded, the annual number has steadily grown. This growth became especially noticeable after 2021, which saw 374 publications, reaching a peak in 2023 with 432 publications. This pattern, particularly in recent years, reflects a significant rise in interest and research focus in this field, as illustrated in Fig. 2.

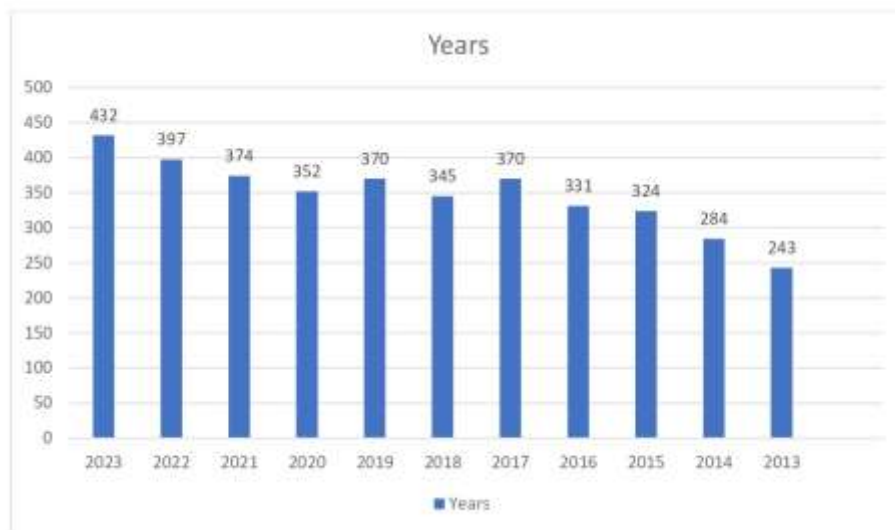


Fig. 2: Distribution of publications by years 2013 to 2023

The journal that has made the most significant contribution to this area of research is *Clinical Oral Implants Research*, which has published 533 articles and garnered 4,094 citations. Its most frequently cited article is titled "Accuracy of dental implant placement with a robotic system in partially edentulous patients: A prospective, single-arm clinical trial," published by John Wiley & Sons and cited 26 times.

Following closely is the *International Journal of Oral and Maxillofacial Implants*, with 544 publications and 1,802 citations. The most cited article from this journal, "Identification of 130 Dental Implant Types Using Ensemble Deep Learning," has been cited 9 times and was published by Quintessence Publishing Company.

Furthermore, *Clinical Implant Dentistry and Related Research* has 354 publications and 2,127 citations, with its most cited article being "Impact of local predisposing/precipitating factors and systemic drivers on peri-implant diseases," which has received 32 citations and is also published by John Wiley & Sons.

This analysis underscores the contributions and output of various scientific journals in the realm of dental implant complications research. Additionally, Table 1 presents the distribution of the most productive journals.

Table 1: The top 10 most productive journals on dental implant complications 2013 to 2023

Journal	TP	TC	cte score	Most cited article	Times cited	Publisher
Clinical Oral Implants Research	533	4094	7.7	Accuracy of dental implant placement with a robotic system in partially edentulous patients: A prospective, single-arm clinical trial	26	John Wiley & Sons
International Journal of Oral and Maxillofacial Implants	544	1802	3.3	Identification of 130 Dental Implant Types Using Ensemble Deep Learning	9	Quintessence Publishing Company
Clinical Implant Dentistry and Related Research	354	2127	6.0	Impact of local predisposing/precipitating factors and systemic drivers on peri-implant diseases	32	John Wiley & Sons
Journal of Prosthetic Dentistry	1333	9336	7.0	Artificial intelligence applications in implant dentistry: A systematic review	74	Elsevier
International Journal of Periodontics and Restorative Dentistry	462	1362	2.9	The New Generation of Subperiosteal Implants for Patient-Specific Treatment of Atrophic Dental Arches: A Literature Review and Two Case Reports	5	Quintessence Publishing Company
Journal of Craniofacial Surgery	3507	5954	1.7	Temporomandibular Joint Disk Displacement: Etiology, Diagnosis, Imaging, and Therapeutic Approaches	47	Wolters Kluwer Health
International Journal of Oral Implantology	103	408	4.0	Implant-supported fixed dental prostheses with cantilever extensions: State of the art and future perspectives	8	Quintessence Publishing Company
Journal of Oral Implantology	282	636	2.3	Digital Workflow for Designing CAD-CAM Custom Abutments of Immediate Implants Based on the Natural Emergence Profile of the Tooth to be Extracted	9	Allen Press
Journal of Oral and Maxillofacial Surgery	1184	4719	4.0	Novel Machine Learning Algorithms for Prediction of Treatment Decisions in Adult Patients With Class III Malocclusion	10	Elsevier
Implant Dentistry	283	1129	4.0	Compatibility of Nonoriginal Abutments with Implants: Evaluation of Microgap at the Implant-Abutment Interface, with Original and Nonoriginal Abutments	311	Wolters Kluwer Health

Note: TP = Total Publications, TC = Total Citation.

On the flip side, a list of the top 10 authors in dental implant complications research (Table 2), highlighting Marco A.B. Esposito and Hom Lay Wang for their high H-indices of 76 and 93, indicating their significant influence in the field since they began publishing in 1995. Most authors are associated with prestigious Italian universities, underscoring Italy's key role in this research area. Other notable authors include Pietro Felice and Massimo del Fabbro, with H-indices of 49 and 59. The inclusion of authors from the U.S., Netherlands, and Switzerland demonstrates a global effort to advance knowledge in dental implant complications, emphasizing the collaborative nature of this important dental research.

Table 2: Top 10 most prolific authors in dental implant complications research

Author	Year of first publication	H-index	Current affiliation	Country
Esposito, Marco A.B.	1995	76	Vita-Salute San Raffaele University	Italy
Felice, Pietro	2000	49	University of Bologna	Italy
Tallarico, Marco	2003	29	University of Sassari	Italy
Wang, Hom Lay	1995	93	University of Michigan School of Dentistry	United States
Barausse, Carlo	2013	27	University of Bologna	Italy
Meloni, Silvio Mario Ario	2006	26	University of Sassari	Italy
Pistilli, Roberto	2006	32	Ospedale San Camillo-Forlanini	Italy
del Fabbro, Massimo	1995	59	University of Milan	Italy
Raghoobar, Gerry Maarten A.	1995	66	University of Groningen	Netherlands
Jung, Ronald Ernst	2002	65	Universität Zürich	Switzerland

The analysis of contributions from the top ten countries on complications related to dental implants shows that the United States and Italy lead in research output, each contributing 21% of the total data. The United States ranks first with 727 publications, primarily supported by the University at Buffalo. Italy follows closely with 722 publications, with the University of Napoli as a major contributor. Following them, Germany and Spain contribute 9%, indicating a moderate level of involvement. Several countries, including China, Sweden, Switzerland, and Brazil, each represent 7%, reflecting a balanced presence in the discourse on dental implant complications. Meanwhile, the United Kingdom and South Korea have the least representation at 6% each.

This highlights the significance of international collaborations and the dedication of academic institutions to advancing scientific research in oral implantology, along with identifying the leading institutions in each country that contribute to knowledge development in this field, as shown in Table 3 and Fig. 3.

Table 3: List of the 10 most productive countries and academic institutions

Rank	Country	TP	Most Productive Academic Institution
1	United States	727	University at Buffalo
2	Italy	722	University of Napoli
3	Spain	306	University of Complutense
4	Germany	294	University of Bonn
5	Sweden	242	University of Gothenburg
6	China	236	Shanghai Jiaotong University
7	Switzerland	230	University of Bern
8	Brazil	224	Federal University of Santa Catarina (UFSC)
9	United Kingdom	197	University of Leeds
10	South Korea	192	Seoul National University Gwanak Dental Hospital

Note: TP = Total Publications

Table 4: Top Occurrences in Dental Implant Complications Research

Keyword	Occurrences	Total link strength
Dental implant	2363	52229
Tooth implant	1909	45970
Tooth implantation	1321	34664
Follow up	1108	33043
Dental implantation, Endosseous	1039	27426
Dental prosthesis, Implant- supported	1036	25895
Treatment outcome	848	24465
Dental restoration failure	754	20196
Controlled study	608	17854
Alveolar bone loss	506	14630

4. Discussion

Dental implants are widely recognized as an effective solution for replacing missing teeth, offering high success rates and significantly enhancing patients' quality of life. Millions of individuals have benefited from these advancements (Sartoretto et al., 2023). However, despite their generally predictable outcomes, a small but noteworthy group of patients experiences implant failure. Factors such as osteoporosis, low bone density, poor bone quality, metabolic bone diseases, the use of bisphosphonates, and a history of progressive periodontal disease increase the risk of failure. Both the quality and quantity of the bone supporting and surrounding the implant play a crucial role in successful osseointegration (Esposito et al., 1998).

Nevertheless, implant failures are categorized into early and late failures. Early failures are generally attributed to factors like poor bone quality, compromised health conditions, inadequate surgical techniques, and unfavorable lifestyle habits. Late failures are typically caused by issues such as occlusal overload, peri-implantitis, poor oral hygiene, and defective implant components (Sakka et al., 2012).

The bibliometric analysis highlights the growth and broad scope of research on dental implant complications, integrating insights from both dentistry and medicine. It examines key trends, influential publications, and emerging areas, offering a concise overview of the evolving field.

Over the past ten years, there has been a significant increase in publications addressing the complications related to dental implant systems. The journals that have made the most substantial contributions to this area of research include *Clinical Oral Implants Research*, which published 533 articles and garnered 4,094 citations. It was followed by the *International Journal of Oral and Maxillofacial Implants*, with 544 publications and 1,802 citations. These journals have consistently featured high-impact studies exploring various aspects of dental implant complications, reflecting a growing academic and clinical interest in understanding and addressing the challenges associated with implantology.

The United States is the most productive country in dental implant research, followed by European nations with a long tradition in implantology, such as Italy, Germany, and Spain. However, the most prolific authors in this field are Marco A.B. Esposito and Hom Lay Wang, who have achieved high H-indices of 76 and 93, respectively. Also, the University at Buffalo and the University of

Napoli are key players in advancing dental implant technology and addressing related complications.

Otherwise, scientific progress is propelled by the refinement of established concepts, the identification of potential improvements, and the tracking of trends through data analysis in scholarly publications. Keywords are essential in this process, enabling the traceability of knowledge development. Emerging researchers often gravitate toward popular keywords, highlighting their importance in guiding the trajectory of current research (Choi et al., 2011). In this study, the most frequently occurring keywords were "dental implant" and "tooth implant." These terms emphasize the central theme of the article analysis, which highlights the importance of accurately addressing complications and ensuring successful outcomes in dental implant procedures. The focus on these keywords reflects the critical role of understanding and mitigating issues associated with dental implants to achieve optimal treatment results.

The long-term success of dental implants is influenced by multiple factors, including accurate diagnosis, comprehensive evaluation, and meticulous treatment planning (Steigenga et al., 2003). However, these clinical steps must be complemented by a deep understanding of the potential complications associated with implants, such as peri-implantitis, mechanical failures, or bone resorption, and their effective management. Recognizing early signs of these complications is crucial, as timely intervention can prevent irreversible damage (Manor et al., 2009).

Furthermore, clinicians should educate patients about proper oral hygiene practices and maintenance protocols, as these play a significant role in minimizing risks. Advanced materials, such as zirconium and PEEK, and innovative techniques, including guided implant surgery, also contribute to enhancing outcomes by reducing mechanical and biological complications (Kligman et al., 2021). Ultimately, the emphasis on prevention through risk assessment, patient compliance, and regular follow-ups underscores the timeless principle that "prevention is better than cure," ensuring not only the longevity of the implant but also the overall well-being of the patient (Vaidya et al., 2012).

In fact, this bibliometric analysis of dental implant complications offers valuable insights into the trends, key research areas, and leading authors in the field. A key strength of this approach lies in its ability to identify patterns in scientific output, highlight collaborations between institutions, and uncover the most cited works, which collectively aid in understanding the broader landscape of implant complications. However, bibliometric studies are limited by their dependence on the quality and completeness of indexed databases, potentially overlooking non-indexed but relevant publications. Additionally, they may fail to capture the nuances of clinical outcomes or patient-specific factors. Future directions in this field should focus on integrating bibliometric findings with systematic reviews and meta-analyses to bridge the gap between quantitative trends and clinical relevance. Moreover, expanding the analysis to include emerging topics such as the role of material science advancements, patient-specific biomechanics, and the impact of digital workflows could enhance the understanding and management of dental implant complications.

5. Conclusion

In conclusion, the findings from this bibliometric analysis underscore the importance of continued research into dental implant complications and their clinical implications. The evolving landscape of implant technology, materials, and diagnostic methods suggests that significant improvements in clinical outcomes are possible through the adoption of new

approaches. However, there remain several challenges, including the need for better preventive measures, long-term outcome data, and patient-centered research. By addressing these gaps, the field of dental implantology can continue to advance, providing more effective solutions for preventing and managing implant complications.

References

- [1] Tjellström A. The father of Osseointegration and the godfather of the BAHA: Professor Per-Ingvar Brånemark, Göteborg Sweden has passed away in his 86th year. *Eur Arch Otorhinolaryngol.* 2015;272(4):779-80. <https://doi.org/10.1007/s00405-015-3581-1>
- [2] Lang, L.A., Hansen, S.E., Olvera, N., Teich, S., 2019. A comparison of implant complications and failures between the maxilla and the mandible. *J Prosthet Dent* 121, 611–617. <https://doi.org/10.1016/j.prosdent.2018.08.002>
- [3] French D, Ofec R, Levin L. Long term clinical performance of 10 871 dental implants with up to 22 years of follow-up: A cohort study in 4247 patients. *Clin Implant Dent Relat Res.* 2021;23(3):289-97. <https://doi.org/10.1111/cid.12994>
- [4] Gupta S, Gupta H, Tandan A. Technical complications of implant-causes and management: A comprehensive review. *Natl J Maxillofac Surg.* 2015;6(1):3-8. DOI: 10.4103/0975-5950.168233
- [5] Hanif A, Qureshi S, Sheikh Z, Rashid H. Complications in implant dentistry. *European Journal of Dentistry.* 2017;11(1):135. https://doi.org/10.4103/ejd.ejd_340_16
- [6] Guruprasad Y, Ibrahim M, Singh K, Shetty S, Garg DK, Srilakshmi D, et al. Assessment of Complications in Dental Implant Surgery. *J Pharm Bioallied Sci.* juill 2024;16(Suppl 3):S2437-9. https://doi.org/10.4103/jpbs.jpbs_261_24
- [7] Stanford CM. Application of oral implants to the general dental practice. *J Am Dent Assoc.* 2005;136(8):1092-100; quiz 1165-6. <https://doi.org/10.14219/jada.archive.2005.0312>
- [8] Berglundh T, Persson L, Klinge B. A systematic review of the incidence of biological and technical complications in implant dentistry reported in prospective longitudinal studies of at least 5 years. *J Clin Periodontol.* 2002;29 Suppl 3:197-212; discussion 232-233. <https://doi.org/10.1034/j.1600-051x.29.s3.12.x>
- [9] Joshi VM, Kandaswamy E. Bibliometric Analysis of Dental Implantology Journals From 1991 to 2023. *Int J Oral Maxillofac Implants.* oct 2024;39(5):193-202. <https://doi.org/10.11607/jomi.10758>
- [10] Sartoretto SC, Shibli JA, Javid K, Cotrim K, Canabarro A, Louro RS, et al. Comparing the Long-Term Success Rates of Tooth Preservation and Dental Implants: A Critical Review. *J Funct Biomater.* mars 2023;14(3):142. <https://doi.org/10.3390/jfb14030142>
- [11] Esposito M, Hirsch JM, Lekholm U, Thomsen P. Biological factors contributing to failures of osseointegrated oral implants. (I). Success criteria and epidemiology. *Eur J Oral Sci* 1998;106:527-51. <https://doi.org/10.1046/j.0909-8836..t01-2-.x>.
- [12] Sakka S, Baroudi K, Nassani MZ. Factors associated with early and late failure of dental implants. *J Investig Clin Dent* 2012;3:258-61. <https://doi.org/10.1111/j.2041-1626.2012.00162.x>.
- [13] Choi J, Yi S, Lee KC. Analysis of the Keyword Networks in MIS Research and Its Implications in Predicting the Knowledge Evolution. *Information & Management.* 2011;48(8):371-381. <https://doi.org/10.1016/j.im.2011.09.004>

- [14] Steigenga JT, al-Shammari KF, Nociti FH, Misch CE, Wang HL. Dental implant design and its relationship to long-term implant success. *Implant Dent.* 2003;12(4):306-17. <https://doi.org/10.1097/01.id.0000091140.76130.a1>
- [15] Manor Y, Oubaid S, Mardinger O, Chaushu G, Nissan J. Characteristics of early versus late implant failure: a retrospective study. *J Oral Maxillofac Surg.* 2009;67(12):2649-52. <https://doi.org/10.1016/j.joms.2009.07.050>
- [16] Kligman S, Ren Z, Chung CH, Perillo MA, Chang YC, Koo H, et al. The Impact of Dental Implant Surface Modifications on Osseointegration and Biofilm Formation. *J Clin Med.* avr 2021;10(8):1641. <https://doi.org/10.3390/jcm10081641>
- [17] Vaidya S, Khalikar A, Dange SP, Desai R. Complications and their Management in Implantology. *International Journal of Prosthodontics and Restorative Dentistry.* déc 2012;2(4):150-5. <https://doi.org/10.5005/jp-journals-10019-1065>