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A bibliometric analysis of the studies on dental implant failure

Farhan Raza Khan,¹ Syed Murtaza Raza Kazmi,² Yusra Fahim Siddiqui³

Abstract

Objective: To identify top 30 studies related to dental implant failures based on bibliometric analysis.

Methods: The bibliometric study was conducted at Aga Khan University, Karachi from April 2021 to June 2021 and comprised database search on Google Scholar used key words "dental implant failures" for studies published between 1990 and 2020. The selected studies were reviewed based on citation count for which the cut-off date was June 1, 2021.

Results: The top 30 papers on dental implant failures had median citation count of 153 (range: 41-1583. Most of the studies were retrospective 11(36.7%), followed by literature reviews 6(20%). The top three contributing journals were the 'International Journal of Oral Maxillofacial Implants' 6(20%), the 'Clinical Oral Implants Research' 5(16.7%) and 'Clinical Implant Dentistry and Related Research' 3(10%). Goteborg University, Sweden, contributed the maximum number of most cited papers 8(26.7%).

Conclusions: Most of the papers in the top-cited on dental implant failures were retrospective studies, and there was only one clinical trial.

Keywords: Dental implants, Dental implant failure, Bibliometrics.

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Introduction

Healthcare professionals update themselves with the current scientific literature using electronic media, conferences, textbooks and peer-reviewed journals.¹ The published scientific literature is growing exponentially and it is estimated that the volume of literature in health sciences doubles every 7 years.² This places the clinicians and researchers in a challenging situation of keeping abreast with the recent knowledge and practices.^{3,4} Bibliometric analysis helps the reader to recognise the most acknowledged articles on the topics of interest.⁵ It

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gives a snapshot of the must-read articles on the given topic. Different parameters are evaluated in the bibliometric analysis, including the citation analysis, which is a simple measure of counting the number of times a particular paper has been cited by other publications.⁶ It is a commonly evaluated parameter in bibliometrics. Papers which are recognised to have significant bearing on a discipline get acknowledged more than the other papers with less impact.⁷ Bibliometric analysis identifies variables such as country, institutions, authors and journals contributing to the discipline of interest.^{8,9} All of this helps the researchers in designing further studies and thus contributing to the scientific enquiry.^{10,11}

With abundant literature already present in various specialties of Medicine, Dentistry, Nursing and Allied Health Sciences, an inquisitive mind might ask the question as to what makes an article a 'classic article'. The definition varies, but a citation count (CC) >400 is usually considered the cut-off.¹² In certain specialties, due to limited volume of literature, CC >100 may be considered classic.¹³ However, Giatsidis et al. suggested that rather than the CC, the citation density (CD) should be considered the valid parameter in evaluating the impact of an article.¹⁴

The current study was planned to identify top 30 studies related to dental implant failures based on bibliometric analysis which could be helpful in formulating the syllabus for short-listing the papers that can be recommended as a must-read or suggested-read in the residency programmes, seminars and journal clubs related to residency/fellowship training programmes in Prosthodontics, Oral Surgery or Implant Dentistry Implantology.

Materials and Methods

The bibliometric study was conducted at Aga Khan University, Karachi from April 2021 to June 2021 and comprised database search on Google Scholar used key words "dental implant failures" for studies published between 1990 and 2020. The citation analysis was carried out on June 1, 2021. Only English-language papers were considered, and there were no exclusions made based on study design. There were 18,900 hits on that search.

The title, year of publication, authors, CC, CD, key words, the name of institution and the country of the corresponding author were recorded. After the screening process, the articles were arranged in the descending order based on CC.

Results

The top 30 papers on dental implant failures had median citation count of 153 (range: 41-1583. Of the total, 4(13.3%) would be labelled as classic with CC >400 (Table-1).

Table-1: Citation analysis of top 30 studies on dental implant failures.

| # | Title | Citations | | Article Type | Country | Key Words |
|----|---|-----------|----|-----------------------------------|--|--|
| | | n | CD | | | |
| 1 | Esposito M, Hirsch JM, Lekholm U, Thomsen P. Biological factors contributing to failures of osseointegrated oral implants.(I). Success criteria and epidemiology. <i>Eur J Oral Sci.</i> 1998;106:527-51. | 1583 | 69 | Systematic Review & Meta-analysis | Uppsala University, Sweden | Dental implants; osseointegration; medical device failure; meta-analysis |
| 2 | Lindquist LW, Carlsson GE, Jemt T. A prospective 15-year follow-up study of mandibular fixed prostheses supported by Osseointegrated implants. <i>Clinical results and marginal bone loss.</i> <i>Clin Oral Implants Res.</i> 1996;7:329-36. | 891 | 37 | Prospective study | Goteborg University, Sweden | Bone resorption, dental implantation, dental prosthesis, longitudinal study, oral hygiene, osseointegration, smoking |
| 3 | Zarb GA, Schmitt A. The longitudinal clinical effectiveness of osseointegrated dental implants: the Toronto study. Part III: Problems and complications encountered. <i>J Prosth Dent.</i> 1990; 64:185-94. | 838 | 28 | Audit | University of Toronto, Canada | No key words |
| 4 | Fransson C, Lekholm U, Jemt T, Berglund T. Prevalence of subjects with progressive bone loss at implants. <i>Clin Oral Implants Res.</i> 2005; 16:440-6. | 450 | 29 | Retro-spective charts review | Goteborg University, Sweden | Bone level, complications, dental implants, human radiographs |
| 5 | Roos J, Sennerby L, Lekholm UL, Jemt T, Gröndahl K, Albrektsson T. A qualitative and quantitative method for evaluating implant success: a 5-year retrospective analysis of the Brånemark implant. <i>Int J Oral Maxillofac Implants.</i> 1997;12:504-14. | 379 | 16 | Retro-spective study | Goteborg University, Sweden | Brånemark system, criteria for evaluation, retrospective study, titanium implants |
| 6 | Bain CA. Smoking and implant failure—benefits of a smoking cessation protocol. <i>Int J Oral Maxillofac Implants.</i> 1996;11:756-9. | 366 | 15 | Prospective study | Dubai School of Dental Medicine | Implant failure, risk factor, smoking, smoking cessation benefits |
| 7 | Hardt CR, Gröndahl K, Lekholm U, Wennström JL. Outcome of implant therapy in relation to experienced loss of periodontal bone support: a retrospective 5-year study. <i>Clin Oral Implants Res.</i> 2002;13:488-94. | 328 | 18 | Retro-spective Study | Goteborg University, Sweden | Bone loss, osseointegration, partial edentulism, periodontitis, posterior maxilla, titanium implants |
| 8 | Chrcanovic BR, Albrektsson T, Wennerberg A. Reasons for failures of oral implants. <i>J Oral Rehabil.</i> 2014;41:443-76. | 300 | 46 | Review Paper | Goteborg University, Sweden | Dental implants, failure, associated conditions, systematic review |
| 9 | Porter JA, Von Fraunhofer JA. Success or failure of dental implants? A literature review with treatment considerations. <i>Gen Dent.</i> 2005; 53:423-32. | 280 | 19 | Review Paper | University of Maryland, USA. | No key words |
| 10 | Snauwaert K, Duyck J, van Steenberghe D, Quirynen M, Naert I. Time dependent failure rate and marginal bone loss of implant supported prostheses: a 15-year follow-up study. <i>Clin Oral Invest.</i> 2000;4:13-20. | 223 | 11 | Cohort Study | Catholic University of Leuven, Belgium | Oral implants - Dental implants Osseointegration failures Marginal bone loss - Brånemark system |
| 11 | Esposito M, Thomsen P, Ericson LE, Lekholm U. Histopathologic observations on early oral implant failures. <i>Int J Oral Maxillofac Implants.</i> 1999;14: 798-810. | 201 | 10 | Histo-pathologic evaluation | Goteborg University, Sweden | Dental implant, early failures, morphology, titanium, ultrastructure |
| 12 | Sakka S, Baroudi K, Nassani MZ. Factors associated with early and late failure of dental implants. <i>J Invest Clin Dent.</i> 2012;3:258-61. | 200 | 25 | Review Paper | Al-Farabi Dental College, Saudi Arabia | Dental implants, early failure, late failure, osseointegration. |
| 13 | Listrom RD, Symington JM. Osseointegrated dental implants in conjunction with bone grafts. <i>Int J Oral Maxillofac Implants.</i> 1988;17:116-8. | 187 | 6 | Case Series | Toronto General Hospital, Canada | Implant dental, titanium, osseointegration, graft bone |
| 14 | Sun HL, Wu YR, Huang C, Shi B. Failure rates of short (≤ 10 mm) dental implants and factors influencing their failure: a systematic review. <i>Int J Oral Maxillofac Implants.</i> 2011;26: 816-25. | 182 | 20 | Systemic Review | Wuhan University, China | Bone quality, dental implants, implant length, implant position, implant surface |
| 15 | Chung DM, Oh TJ, Lee J, Misch CE, Wang HL. Factors affecting late implant bone loss: a retrospective analysis. <i>Int J Oral Maxillofac Implants.</i> 2007;22:117-26. | 158 | 11 | Retro-spective Study | University of Michigan, USA | Implant maintenance, implant surfaces, late implant bone loss, peri-implantitis |
| 16 | Manor Y, Oubaid S, Mardinger O, Chaushu G, Nissan J. Characteristics of early versus late implant failure: a retrospective study. <i>J Oral Maxillofac Surg.</i> 2009;67:2649-52. | 149 | 14 | Retro-spective Study | Tel Aviv University, Israel | No key words |
| 17 | Albrektsson T. On long-term maintenance of the osseointegrated response. <i>Aus Prosthodont J.</i> 1993;7:15. | 144 | 5 | Review | Goteborg University, Sweden | No key words |
| 18 | Kronström M, Svenson B, Hellman M, Persson GR. Early implant failures in patients treated with Brånemark System titanium dental implants: a retrospective study. <i>Int J Oral Maxillofac Implants.</i> 2001;16. | 135 | 7 | Retro-spective study | Central Hospital, Sweden | Early implant failure, endosseous dental implantation, osseointegration, titanium |

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|----|--|-----|----|-------------------------------------|--|---|
| 19 | Tabanella G, Nowzari H, Slots J. Clinical and microbiological determinants of ailing dental implants. <i>Clin Implant Dent Rel Res.</i> 2009;11:24-36. | 130 | 11 | Cross sectional study | University of Southern California, USA | Oral implants, peri-implant bone loss, peri-implantitis, peri-implant tissue, predictors of ailing dental implants |
| 20 | Schwartz-Arad D, Laviv A, Levin L. Failure causes, timing, and cluster behavior: an 8-year study of dental implants. <i>Implant Dent.</i> 2008;17:200-7. | 128 | 10 | Audit | Schwartz-Arad Surgical Center, Israel | Dental implants; implant failure; success; survival; cluster pattern; prosthetic phase; surgical phase |
| 21 | Sakka S, Coulthard P. Implant failure: etiology and complications. <i>Med Oral Patol Oral Cir Bucal.</i> 2011;16(1):e42-4. | 124 | 13 | Review Paper | University of Albath, Syria | Implant failure, peri-implantitis, marginal bone loss, implant mobility |
| 22 | Chen S, Darby I. Dental implants: Maintenance, care and treatment of peri-implant infection. <i>Aus Dent J.</i> 2003;48(4):212-20. | 124 | 7 | Review Paper | University of Melbourne Australia | Osseointegration, peri-implant mucositis, periimplantitis. |
| 23 | Tonetti MS. Determination of the success and failure of root-form osseointegrated dental implants. <i>Adv Dent Res.</i> 1999;13:173-80. | 102 | 5 | Prospective study | University of Bern Switzerland | Dental implants, infection, biomechanical overload, risk, survival, susceptibility, review. |
| 24 | Esposito M, Thomsen P, Mölne J, Gretzer C, Ericson LE, Lekholm U. Immunohistochemistry of soft tissues surrounding late failures of Brånemark implants. <i>Clin Oral Implants Res.</i> 1997;8:352-66. | 94 | 4 | Immuno-histochemistry study | Goteborg University, Sweden | Dental implants, titanium implant failure, macrophages, immune cells, |
| 25 | Tolstunov L. Dental implant success-failure analysis: a concept of implant vulnerability. <i>Implant Dent.</i> 2006;15:341-6. | 75 | 5 | Review Paper | University of Pacific School of Dentistry, USA | Osseointegration; implant vulnerability; bone connection; natural teeth; ankylosed teeth |
| 26 | Gabbert O, Koob A, Schmitter M, Rammelsberg P. Implants placed in combination with an internal sinus lift without graft material: an analysis of short-term failure. <i>J Clin Periodontol.</i> 2009;36:177-83. | 74 | 6 | Clinical Trial | University Hospital Heidelberg, Germany | Dental implants; graft; internal sinus lift; osteotome; sinus floor elevation |
| 27 | Wu X, Al-Abedalla K, Rastikerdar E, Abi Nader S, Daniel NG, Nicolau B, Tamimi F. Selective serotonin reuptake inhibitors and the risk of osseointegrated implant failure: a cohort study. <i>J Dent Res.</i> 2014; 93:1054-61. | 72 | 12 | Cohort Study | McGill University, Canada | Medical devices, risk factors, dental implants, bone remodeling, osseointegration, epidemiology |
| 28 | Vervaeke S, Collaert B, Cosyn J, Descheppe E, De Bruyn H. A multifactorial analysis to identify predictors of implant failure and peri-implant bone loss. <i>Clin Implant Dent Rel Res.</i> 2015;17:e298-307. | 70 | 12 | Retro-spective cohort study | Faculty of Medicine & Health Sciences, Ghent University, Belgium | Dental implant, implant survival, multifactorial, peri-implant bone loss, predictor |
| 29 | Zhou Y, Gao J, Luo L, Wang Y. Does bruxism contribute to dental implant failure? A systematic review and meta-analysis. <i>Clin Implant Dent Rel Res.</i> 2016;18:410-20. | 64 | 14 | Systematic review and meta-analysis | Wuhan University, China | Bruxism, complication, dental implant, implant failure |
| 30 | Schimmel M, Srinivasan M, McKenna G, Müller F. Effect of advanced age and/or systemic medical conditions on dental implant survival: A systematic review and meta-analysis. <i>Clin Oral Implants Res.</i> 2018;29:311-30. | 41 | 19 | Systematic review and meta-analysis | University of Bern, Switzerland | Aging, Alzheimer's disease, bisphosphonates, cancer, cardiovascular disease, chronic obstructive pulmonary disease, cirrhosis of the liver, dementia, dental implants, stroke, systematic review. |

n: Citation count, CD: Citation density.

Table-2: List of top authors, journals, institutions and countries contributing to the most cited papers on dental implants failure.

| Top authors | | Article serial # (as shown in table 1) | Count* |
|-------------------------|--|--|--------|
| 1 | Lekholm U | 1,4,5,7,11,24 | 6 |
| 2 | Albrektsson T | 5,8,17 | 3 |
| 3 | Esposito M | 1,11,24 | 3 |
| 4 | Jemt T | 2,4,5 | 3 |
| 5 | Thomsen P | 1,11,24 | 3 |
| Top journals | | | |
| 1 | International Journal of Oral & Maxillofacial Implants | 5,6,11,14,15,18 | 6 |
| 2 | Clinical Oral Implants Research | 2,4,7,24,30 | 5 |
| 3 | Clinical Implant Dentistry and Related Research | 19, 28,29 | 3 |
| Top institutions | | | |
| 1 | Goteborg University, Sweden | 2,4,5,7,8,11,17,24, | 8 |
| 2 | University of Bern, Switzerland | 14,29 | 2 |
| 3 | Wuhan University, China | 23,30 | 2 |
| Top countries | | | |
| 1 | Sweden | 1,2,4,5,7,8,11,17,18,24 | 10 |
| 2 | United States of America | 9,15,19,25 | 4 |
| 3 | Canada | 3,13,27 | 3 |

*Only top 3-5 articles are reported, and, therefore, the numbers do not necessarily sum up to 30.

Table-3: Study designs of the selected papers.

| No. | Study design | Article serial # (as shown in table 1) | Count |
|-----|---|--|-------|
| 1 | Systematic review / Meta-analysis | 1, 14, 29, 30 | 4 |
| 2 | Clinical trial | 26 | 1 |
| 3 | Prospective study/ Cohort | 2, 6, 10, 27 | 4 |
| 4 | Retrospective study/ Case-control | 3, 4, 5, 7, 15, 16, 18, 20, 23, 25, 28 | 11 |
| 5 | Cross sectional study | 19 | 1 |
| 6 | Literature review | 8, 9, 12, 17, 21, 22 | 6 |
| 7 | Case report/ Case series | 13 | 1 |
| 8 | Histopathology/ Immunohistochemical investigation | 11, 24 | 2 |

The top three contributing journals were the 'International Journal of Oral Maxillofacial Implants' 6(20%), the 'Clinical Oral Implants Research' 5(16.7%) and 'Clinical Implant Dentistry and Related Research' 3(10%), while the Goteborg University, Sweden, contributed the maximum number of the most cited papers 8(26.7%) (Table-2).

Most of the studies were retrospective 11(36.7%), followed by literature reviews 6(20%) (Table-3).

Discussion

Dental implants have been popularised by Dr Branemark, a Swedish orthopaedic surgeon and scientist.¹⁵ He revolutionised the field of Dental Implantology with the introduction of titanium-based endosseous dental implants and the discovery of the phenomenon of osseointegration. Dental implant has become a popular method of replacing teeth worldwide. To date, millions of people have benefitted from dental implants. However, despite high predictability in the outcome of implants, a small but important subset of patients do experience failure.^{16,17} Subjects with osteoporosis, low bone volume, poor quality of bone, presence of metabolic bone disease, use of bisphosphonates and history of progressive periodontal disease etc. are at a greater risk of implant failure. Both the quality and quantity of bone that supports and surrounds the implant influence the osseointegration of implant.¹⁸⁻²⁰

Implant failures are categorised as early and late failures.²¹ Early implant failures are caused by poor bone quality, medically compromised patients, like those with uncontrolled diabetes, inadequate surgical technique, chronic drug or alcohol consumption, and smoking status, whereas late causes of failures are occlusal overload/excessive stress, peri-implantitis and poor oral hygiene, and defective implant components.^{17,22,23} The most common reasons for late or delayed implant failure include implant overloading or fracture, and/or peri-implantitis.²²

Bibliometric analysis can serve as a useful tool for clinicians

and researchers to appraise published literature on a given topic.⁷ The current study was carried out to identify the papers on dental implant failures that have the maximum impact on the knowledge and understanding of this topic. Ten out of the 30 top-cited papers on dental implant failures were from Sweden. This shows that Swedish researchers are at the forefront of research on dental implant and its failures.

Most of the papers in the top-cited list were retrospective studies and audits. It is logistically easier to carry out and publish retrospective studies as mostly there are no issues of funding associated with them. Moreover, the sample size or number of observations are usually higher, resulting in comparatively easier publication. In the present report, 11 of the 30 studies had retrospective study design. The importance of systematic reviews and meta-analysis cannot be underestimated, as they synthesise data from primary studies to yield the highest level of evidence that forms the basis of the evidence-based practice (EBP).^{24,25} In the present report, there were 4 systematic reviews/meta-analyses. Two of them were conducted at Wuhan University, China.

Literature reviews and narrative reviews do not provide a high level of evidence, and they have inherent biases. Despite increasing emphasis on evidence-based dentistry (EBD), it is worrying to observe that in the present list, 6 articles were literature reviews. The lack of randomised controlled trial (RCTs) in the list is a matter of concern. Ideally, owing to the level of evidence generated, the clinical trials should be cited more than the retrospective studies.

The limitation of the current study is that it has listed the paper based on CC which actually reflects the popularity of a paper rather than its true clinical significance and the impact on practice. Moreover, starting the literature search from 1990 was an arbitrary starting point, mainly to cater to electronically published papers as prior to 1990, several journals had print-only editions. Some important papers published before the cut-off point could have made it to the top cited list but were left unattended. Lastly, non-English literature was ignored, making citations from non-English literature, especially from Chinese, South Korean or Brazilian publications, excluded.

Conclusions

The CC of the top 30 papers on dental implant failure ranged from 41 to 1583. Most of the papers in the top

cited list were retrospective studies, followed by literature review and systematic reviews. There was only one clinical trial in the list.

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Conflict of Interest: None.

Source of Funding: None.

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