REVIEW ARTICLE

A bibliometric analysis of the studies on dental implant failure

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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 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.

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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. Eur J Oral Sci. 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. Clinical results and marginal bone loss. Clin Oral Implants Res.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. J Prosth Dent.1990; 64:185-94.	838	28	Audit	University of Toronto, Canada	No key words
4	Fransson C, Lekholm U, Jemt T, Berglundh T. Prevalence of subjects with progressive bone loss at implants. Clin Oral Implants Res. 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. Int J Oral Maxillofac Implants. 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. Int J Oral Maxillofac Implants.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. Clin Oral Implants Res. 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. J Oral Rehabil. 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. Gen Dent. 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. Clin Oral Invest. 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. Int J Oral Maxillofac Implants. 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. J Invest Clin Dent. 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. Int J Oral Maxillofac Implants. 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 ($\leq$ 10 mm) dental implants and factors influencing their failure: a systematic review. Int J Oral Maxillofac Implants. 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. Int J Oral Maxillofac Implants. 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. J Oral Maxillofac Surg. 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. Aus Prosthodont J. 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. Int J Oral Maxillofac Implants. 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. Clin Implant Dent Rel Res. 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. Implant Dent. 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. Med Oral Patol Oral Cir Bucal. 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. Aus Dent J. 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. Adv Dent Res. 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. Clin Oral Implants Res. 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. Implant Dent. 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. J Clin Periodontol. 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. J Dent Res. 2014; 93:1054-61.	72	12	Cohort Study	McGill University, Canada	Medical devices, risk factors, dental implants, bone remodeling, osseointergration, epidemiology
28	Vervaeke S, Collaert B, Cosyn J, Deschepper E, De Bruyn H. A multifactorial analysis to identify predictors of implant failure and peri-implant bone loss. Clin Implant Dent Rel Res. 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. Clin Implant Dent Rel Res. 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. Clin Oral Implants Res. 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.

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