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The Top 200 Cited Articles in Restorative Dentistry Between 1945-2019: Bibliometric Analysis Study

1945-2019 Arası Restoratif Diş Hekimliğinde En Çok Atıf Alan 200 Makale: Bibliyometrik Analiz Çalışması

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ABSTRACT Objectives: The study aimed to identify the top 200 most-cited articles from development to treatment in restorative dentistry and related multidisciplinary fields using in-depth bibliometric analysis. **Material and Methods:** The top 200 most-cited articles published from 1945 through October 18, 2019, were retrieved using "Cited Reference Search" tool of the ISI Web of Knowledge. Then, previous names of the journals were also investigated in order not to skip and exclude them from the study. We also extensively investigated other journals to cover all articles related to dentistry. The top 200 most-cited articles were analyzed, and the results of the study were summarized using descriptive statistics. **Results:** The top 200 most-cited articles have been published between 1954 and 2012 in 78 different journals, all in English language. These articles were cited 112,616 times and the most cited article had 2532 citations. DH Pashley and subsequently B Van Meerbeek published the most cited articles. The number of articles published in the United States was the highest in this list. Catholic University of Leuven was the institution with the highest number of articles published. Most of the top-cited articles were in the basic science field, and the topic was dental caries and/or dental plaque. **Conclusion:** This study revealed that basic researches and reviews were the studies which had received the most citations, respectively. A very low number of studies on clinical trial and a relatively low level of evidence clearly indicate that there is a need for high-level evidence studies such as meta-analyses, systematic reviews, or randomized controlled trials.

Keywords: Bibliometric analysis; citation analysis; Institute for Scientific Information web of knowledge; restorative dentistry

ÖZET Amaç: Bu çalışmanın amacı, bibliyometrik analiz kullanılarak restoratif diş hekimliği ve ilgili multidisipliner alanlarda diş gelişiminden restoratif diş tedavisine kadar en çok alıntı yapılan 200 makaleyi belirlemektir. **Gereç ve Yöntemler:** 1945 yılından 18 Ekim 2019 yılına kadar en çok alıntı yapılan 200 makale Institute for Scientific Information Web of Knowledge'in "Cited Reference Search" aracı kullanılarak alındı. Daha sonra dergilerin eski isimleri de atlanmaması ve çalışmanın dışında bırakılmaması için incelenmiştir. Diş hekimliği ile ilgili tüm makaleleri kapsayacak şekilde diğer dergiler de kapsamlı bir şekilde araştırıldı. En çok alıntı yapılan 200 makale analiz edildi ve çalışmanın sonuçlarını özetlemek için tanımlayıcı istatistik kullanıldı. **Bulgular:** En çok atıf alan 200 makale 1954 ile 2012 yılları arasında 78 farklı dergide tamamı İngilizce olarak yayınlandı. Bu makaleler 112.616 kez alıntılanmış ve en çok atıf alan makale 2.532 atıf almıştır. DH Pashley ve ardından B Van Meerbeek en çok alıntı yapılan makaleleri yayınladı. Amerika Birleşik Devletleri'nde yayınlanan makale sayısı bu listede en yüksek olanıydı. Leuven Katolik Üniversitesi en çok makale yayınlayan kurum oldu. En çok alıntı yapılan makalelerin çoğu temel bilim alanındaydı ve konu diş çürükleri ve/veya diş plağıydı. **Sonuç:** Bu çalışma, temel araştırma ve derlemelerin sırasıyla en çok atıf alan çalışmalar olduğunu ortaya koymuştur. Klinik araştırmalarla ilgili çok az sayıda çalışma ve nispeten düşük düzeyde kanıt olduğunu metaanalizler, sistematik incelemeler veya randomize kontrollü araştırmalar gibi yüksek düzeyli kanıt çalışmalarına ihtiyaç olduğunu açıkça göstermektedir.

Anahtar Kelimeler: Bibliyometrik analiz; atıf analizi; Institute for Scientific Information web of knowledge; restoratif diş hekimliği

The field of bibliometrics is citation analysis. Bibliometric analysis helps to evaluate the correctness of the underlying data and ensure information about the background of a study on the correct interpretation of quantitative results.[1] New ideas usually arise from highly cited articles and these articles can also be a source of solutions to problems or questions that await answers. Too many citations from an arti-

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cle may also indicate that this article is a reliable source for researchers to define their methods or justify their views.[2]

The Institute for Scientific Information (ISI) compiles the most relevant bibliometric information from scientific articles published since 1945, but the Science Citation Index (SCI), a specific tool for measuring citations, has been available since 1962.[3] The SCI developed by WoS, Clarivate Analytics (former ISI, later Thomson Reuters) has made possible to conduct large-scale bibliometric research.[4] The journals indexed in WoS dominate citation impact indicators.[4] Over the years, there have been comprehensive additions in many areas and the coverage of WoS has reached to 34,502 journals today.[5] The WoS platform has extended the scope of the Core Collection by hosting citation databases of different suppliers, such as the BIOSIS Citation Index, the Russian SCI, the Chinese Science Citation Database, and the SciELO Citation Index, also including specialized indexes such as Medline, Inspec, KCI (Korean Journal Database) and the patent resources like the Derwent Innovations Index.[5]

There are many citation analyses and top-cited articles available in the field of medicine and dentistry.[6-35] Some citation studies were based on articles published in several dentistry journals, articles published in a single journal or articles published by authors in a single country.[3,6-10] In bibliometric studies, although the authors focused on special topics, theissue of odontogenesis to restorative treatment was not taken into account by the authors.[11-15]

Therefore, this study, provide a wider perspective to evaluate the studies in these issues, will enable us to foresee the future developments and will direct our studies in this direction. Thus, the study aimed to identify the 200 top-cited articles regarding odontogenesis to restorative dentistry fields and to conduct an updated descriptive analysis to identify the current implications of these articles.

MATERIAL AND METHODS

In this retrospective analysis, Web of Science (Clarivate Analytics Co.,Philadelphia, PA), an online platform (http://www.webofknowledge.com) providing bibliographic data on scientific materials, was screened in three stages to determine the top 200 most-cited articles regarding odontogenesis and treatment in operative dentistry (Table 1).

In the first stage, we used 'Web of Science Group Master Journal List' (mjl.clarivate.com) to find the journals in our scope. In the journal search section, we used to "Science Index Expanded" as the web of science coverage and "Dentistry, Oral Surgery & Medicine" as the category filter. As a result, 91 journals were listed. Then, the citation numbers of all articles published in those journals from 1945 through October 18, 2019, were determined using "Cited Reference Search" tool. Since different numbers of articles appeared in the long and abbreviated name of the journals, the journals were scanned again with their abbreviated names as suggested by the database. Without limitation, all research was performed by using 'All Databases' options and the result was 465,339 articles (n=465,339).

In the second stage, if there were any changes in the names of the journals in the time period that was determined for search (from 1945 through October 18, 2019), the ex-names of the journals were found in order not to exclude them from our research. The old/previous names of each journal were searched in Google Scholar, PubMed and Elsevier's Scopus and included in the research with the same search option. As in the first stage, the abbreviated names suggested by the database for the journal's formerly known names were searched by using 'Cited Reference Search' tool in the 'All Databases' option. This search resulted in 68,742 articles (n=68,742). The journals which contained three or more articles, which are among top-cited articles, along with their formerly known names are shown in Table 2.

In the third stage, to prevent exclusion of other journals containing articles related to dentistry, an extensive screening was performed. This time, using the "Advanced Search" option, the proposed query set [SU= (Dentistry, Oral Surgery & Medicine)] was scanned on 'All Databases' and this search resulted in 746,476 articles (n=746,476). Later, the draft article list was formed, and the list was compared with other draft lists for duplicates.

TABLE 1: Top 200 articles from tooth development to restorative dentistry.

Rank	Article	No. of citations
1	Birkedal-Hansen H, Moore WG, Bodden MK, Windsor LJ, Birkedal-Hansen B, DeCarlo A, Engler JA. Matrix metalloproteinases: a review. Crit Rev Oral Biol Med. 1993;4(2):197-250.	2,532
2	Löe H. The Gingival Index, the Plaque Index and the Retention Index Systems. J Periodontol. 1967;38(6):Suppl:610-616.	2,197
3	Loesche WJ. Role of Streptococcus mutans in human dental decay. Microbiol Rev. 1986;50(4):353-380.	2,051
4	Davey ME, O'toole GA. Microbial biofilms: from ecology to molecular genetics. Microbiol Mol Biol Rev. 2000;64(4):847-867.	1,673
5	Hamada S, Slade HD. Biology, immunology, and cariogenicity of Streptococcus mutans. Microbiol Rev. 1980;44(2):331-384.	1,428
6	Aas JA, Paster BJ, Stokes LN, Olsen I, Dewhirst FE. Defining the normal bacterial flora of the oral cavity. J Clin Microbiol. 2005;43(11):5721-5732.	1,408
7	Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. J Dent Res. 1955;34(6):849-853.	1,361
8	O'Leary TJ, Drake RB, Naylor JE. The plaque control record. J Periodontol. 1972;43(1):38.	1,214
9	Gronthos S, Brahim J, Li W, Fisher LW, Cherman N, Boyde A, DenBesten P, Robey PG, Shi S. Stem cell properties of human dental pulp stem cells. J Dent Res. 2002;81(8):531-535.	1,201
10	Van Meerbeek B, De Munck J, Yoshida Y, Inoue S, Vargas M, Vijay P, Van Landuyt K, Lambrechts P, Vanherle G. Buonocore memorial lecture. Adhesion to enamel and dentin: current status and future challenges. Oper Dent. 2003;28(3):215-235.	1,143
11	Ajdić D, McShan WM, McLaughlin RE, Savić G, Chang J, Carson MB, Primeaux C, Tian R, Kenton S, Jia H, Lin S, Qian Y, Li S, Zhu H, Najar F, Lai H, White J, Roe BA, Ferretti JJ. Genome sequence of Streptococcus mutans UA159, a cariogenic dental pathogen. Proc Natl Acad Sci U S A. 2002;99(22):14434-14439.	1,131
12	Dewhirst FE, Chen T, Izard J, Paster BJ, Tanner AC, Yu WH, Lakshmanan A, Wade WG. The human oral microbiome. J Bacteriol. 2010;192(19):5002-5017.	1,097
13	Clarkson TW, Magos L, Myers GJ. The toxicology of mercury--current exposures and clinical manifestations. N Engl J Med. 2003;349(18):1731-1737.	1,085
14	Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye C. The global burden of oral diseases and risks to oral health. Bull World Health Organ. 2005;83(9):661-669.	1,057
15	Petersen PE. The World Oral Health Report 2003: continuous improvement of oral health in the 21st century-the approach of the WHO Global Oral Health Programme. Community Dent Oral Epidemiol. 2003;31 Suppl 1:3-23.	1,051
16	Greene JC, Vermillion JR. The Simplified oral hygiene index. J Am Dent Assoc. 1964;68(1):7-13.	1,040
17	De Munck J, Van Landuyt K, Peumans M, Poitevin A, Lambrechts P, Braem M, Van Meerbeek B. A critical review of the durability of adhesion to tooth tissue: methods and results. J Dent Res. 2005;84(2):118-132.	1,034
18	Moorrees CF, Fanning EA, Hunt EE Jr. Age variation of formation stages for ten permanent teeth. J Dent Res. 1963;42 (6):1490-1502.	1,034
19	Kakehashi S, Stanley HR, Fitzgerald RJ. The effects of surgical exposures of dental pulps in germ-free and conventional laboratory rats. Oral Surg Oral Med Oral Pathol. 1965;20:340-349.	1,028
20	Nakabayashi N, Kojima K, Masuhara E. The promotion of adhesion by the infiltration of monomers into tooth substrates. J Biomed Mater Res. 1982;16(3):265-273.	996
21	Satokata I, Maas R. Msx1 deficient mice exhibit cleft palate and abnormalities of craniofacial and tooth development. Nat Genet. 1994;6(4):348-356.	978
22	Selwitz RH, Ismail AI, Pitts NB. Dental caries. Lancet. 2007;369(9555):51-59.	970
23	Slade GD. Derivation and validation of a short-form oral health impact profile. Community Dent Oral Epidemiol. 1997;25(4):284-290.	953
24	Turesky S, Gilmore ND, Glickman I. Reduced plaque formation by the chloromethyl analogue of victamine C. J Periodontol. 1970;41(1):41-43.	865
25	Ambrose SH. Preparation and characterization of bone and tooth collagen for isotopic analysis. J Archaeol Sci. 1990;17(4):431-451.	847
26	Feilzer AJ, De Gee AJ, Davidson CL. Setting stress in composite resin in relation to configuration of the restoration. J Dent Res. 1987;66(11):1636-1639.	828
27	Gold OG, Jordan HV, Van Houte J. A selective medium for Streptococcus mutans. Arch Oral Biol. 1973;18(11):1357-1364.	817

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TABLE 1: Top 200 articles from tooth development to restorative dentistry *(continued)*.

Rank	Article	No. of citations
28	Peppas NA, Langer R. New challenges in biomaterials. Science. 1994;263(5154):1715-1720.	810
29	Sodek J, Ganss B, McKee MD. Osteopontin. Crit Rev Oral Biol Med. 2000;11(3):279-303.	794
30	Olea N, Pulgar R, Pérez P, Olea-Serrano F, Rivas A, Novillo-Fertrell A, Pedraza V, Soto AM, Sonnenschein C. Estrogenicity of resin-based composites and sealants used in dentistry. Environ Health Perspect. 1996;104(3):298-305.	768
31	Humphrey SP, Williamson RT. A review of saliva: normal composition, flow, and function. J Prosthet Dent. 2001;85(2):162-169.	762
32	Jernvall J, Thesleff I. Reiterative signaling and patterning during mammalian tooth morphogenesis. Mech Dev. 2000;92(1):19-29.	714
33	Quigley GA, Hein JW. Comparative cleansing efficiency of manual and power brushing. J Am Dent Assoc. 1962;(1);65:26-9.	712
34	Zach L, Cohen G. Pulp response to externally applied heat. Oral Surg Oral Med Oral Pathol. 1965;19:515-530.	691
35	Ferracane JL. Resin composite--state of the art. Dent Mater. 2011;27(1):29-38.	687
36	Van Landuyt KL, Snauwaert J, De Munck J, Peumans M, Yoshida Y, Poitevin A, Coutinho E, Suzuki K, Lambrechts P, Van Meerbeek B. Systematic review of the chemical composition of contemporary dental adhesives. Biomaterials. 2007;28(26):3757-3785.	677
37	Ayoob S, Gupta AK. Fluoride in drinking water: A review on the status and stress effects. Crit Rev Env Sci Tec. 2006;36(6):433-487.	664
38	Breschi L, Mazzoni A, Ruggeri A, Cadenaro M, Di Lenarda R, De Stefano Dorigo E. Dental adhesion review: aging and stability of the bonded interface. Dent Mater. 2008;24(1):90-101.	663
39	Yoshida Y, Nagakane K, Fukuda R, Nakayama Y, Okazaki M, Shintani H, Inoue S, Tagawa Y, Suzuki K, De Munck J, Van Meerbeek B. Comparative study on adhesive performance of functional monomers. J Dent Res. 2004;83(6):454-458.	658
40	Clarkson TW. The three modern faces of mercury. Environ Health Perspect. 2002;110 Suppl 1:11-23.	637
41	Bollen CM, Lambrechts P, Quirynen M. Comparison of surface roughness of oral hard materials to the threshold surface roughness for bacterial plaque retention: a review of the literature. Dent Mater. 1997;13(4):258-269.	635
42	Sano H, Shono T, Sonoda H, Takatsu T, Ciucchi B, Carvalho R, Pashley DH. Relationship between surface area for adhesion and tensile bond strength--evaluation of a micro-tensile bond test. Dent Mater. 1994;10(4):236-240.	609
43	Pashley DH, Tay FR, Yiu C, Hashimoto M, Breschi L, Carvalho RM, Ito S. Collagen degradation by host-derived enzymes during aging. J Dent Res. 2004;83(3):216-221.	603
44	Navazesh M. Methods for collecting saliva. Ann N Y Acad Sci. 1993;694(1):72-77.	601
45	Palmer LC, Newcomb CJ, Kaltz SR, Spoerke ED, Stupp SI. Biomimetic systems for hydroxyapatite mineralization inspired by bone and enamel. Chem Rev. 2008;108(11):4754-4783.	599
46	Ferracane JL. Hygroscopic and hydrolytic effects in dental polymer networks. Dent Mater. 2006;22(3):211-222.	595
47	Quirynen M, Bollen CM. The influence of surface roughness and surface-free energy on supra- and subgingival plaque formation in man. A review of the literature. J Clin Periodontol. 1995;22(1):1-14.	595
48	Mattila KJ, Nieminen MS, Valtonen VV, Rasi VP, Kesäniemi YA, Syrjälä SL, Jungell PS, Isoluoma M, Hietaniemi K, Jokinen MJ. Association between dental health and acute myocardial infarction. BMJ. 1989;298(6676):779-781.	592
49	Johnston WM, Kao EC. Assessment of appearance match by visual observation and clinical colorimetry. J Dent Res. 1989;68(5):819-822.	592
50	Marsh PD. Are dental diseases examples of ecological catastrophes? Microbiology. 2003;149(Pt 2):279-294.	587
51	Sonoyama W, Liu Y, Yamaza T, Tuan RS, Wang S, Shi S, Huang GT. Characterization of the apical papilla and its residing stem cells from human immature permanent teeth: a pilot study. J Endod. 2008;34(2):166-171.	584
52	Gorelick L, Geiger AM, Gwinnett AJ. Incidence of white spot formation after bonding and banding. Am J Orthod. 1982;81(2):93-98.	578
53	Löe H, Schiott CR. The effect of mouthrinses and topical application of chlorhexidine on the development of dental plaque and gingivitis in man. J Periodontal Res. 1970;5(2):79-83.	573
54	Gustafsson BE, Quensel CE, Lanke LS, Lundqvist C, Grahnen H, Bonow BE, Krasse B. The Vipeholm dental caries study; the effect of different levels of carbohydrate intake on caries activity in 436 individuals observed for five years. Acta Odontol Scand. 1954;11(3-4):232-264.	571
55	Halliwell B, Clement MV, Long LH. Hydrogen peroxide in the human body. FEBS Lett. 2000;486(1):10-3.	569
56	Hibst R, Keller U. Experimental studies of the application of the Er:YAG laser on dental hard substances: I. Measurement of the ablation rate. Lasers Surg Med. 1989;9(4):338-344.	569
57	Davidson CL, de Gee AJ, Feilzer A. The competition between the composite-dentin bond strength and the polymerization contraction stress.J Dent Res. 1984;63(12):1396-1399.	565

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TABLE 1: Top 200 articles from tooth development to restorative dentistry *(continued)*.

Rank	Article	No. of citations
58	Van Meerbeek B, Yoshihara K, Yoshida Y, Mine A, De Munck J, Van Landuyt KL. State of the art of self-etch adhesives. Dent Mater. 2011;27(1):17-28.	551
59	Hammarström L. Enamel matrix, cementum development and regeneration. J Clin Periodontol. 1997;24(9):658-668.	543
60	Peumans M, Kanumilli P, De Munck J, Van Landuyt K, Lambrechts P, Van Meerbeek B. Clinical effectiveness of contemporary adhesives: a systematic review of current clinical trials. Dent Mater. 2005;21(9):864-881.	539
61	Blatz MB, Sadan A, Kern M. Resin-ceramic bonding: a review of the literature. J Prosthet Dent. 2003;89(3):268-274.	535
62	Kolenbrander PE, Andersen RN, Blehert DS, Egland PG, Foster JS, Palmer RJ Jr. Communication among oral bacteria. Microbiol Mol Biol Rev. 2002;66(3):486-505.	534
63	Marcenes W, Kassebaum NJ, Bernabé E, Flaxman A, Naghavi M, Lopez A, Murray CJ. Global burden of oral conditions in 1990-2010: a systematic analysis. J Dent Res. 2013;92(7):592-597.	531
64	Peutzfeldt A. Resin composites in dentistry: the monomer systems. Eur J Oral Sci. 1997;105(2):97-116.	530
65	Teughels W, Van Assche N, Sliepen I, Quirynen M. Effect of material characteristics and/or surface topography on biofilm development. Clin Oral Implants Res. 2006;17 Suppl 2:68-81.	523
66	Kern M, Wegner SM. Bonding to zirconia ceramic: adhesion methods and their durability. Dent Mater. 1998;14(1):64-71.	522
67	McLean JW, von Fraunhofer JA. The estimation of cement film thickness by an in vivo technique. Br Dent J. 1971;131(3):107-111.	521
68	Ismail AI, Sohn W, Tellez M, Amaya A, Sen A, Hasson H, Pitts NB. The International Caries Detection and Assessment System (ICDAS): an integrated system for measuring dental caries. Community Dent Oral Epidemiol. 2007;35(3):170-178.	517
69	Marshall GW Jr, Marshall SJ, Kinney JH, Balooch M. The dentin substrate: structure and properties related to bonding. J Dent. 1997;25(6):441-458.	515
70	Kolenbrander PE. Oral microbial communities: biofilms, interactions, and genetic systems. Annu Rev Microbiol. 2000;54(1):413-437.	510
71	Dassule HR, Lewis P, Bei M, Maas R, McMahon AP. Sonic hedgehog regulates growth and morphogenesis of the tooth. Development. 2000;127(22):4775-4785.	510
72	Busscher HJ, Weerkamp AH, van der Mei HC, van Pelt AW, de Jong HP, Arends J. Measurement of the surface free energy of bacterial cell surfaces and its relevance for adhesion. Appl Environ Microbiol. 1984;48(5):980-983.	510
73	Petersen PE, Yamamoto T. Improving the oral health of older people: the approach of the WHO Global Oral Health Programme. Community Dent Oral Epidemiol. 2005;33(2):81-92.	505
74	Sano H, Takatsu T, Ciucchi B, Horner JA, Matthews WG, Pashley DH. Nanoleakage: leakage within the hybrid layer. Oper Dent. 1995;20(1):18-25.	505
75	Andrews LF. The six keys to normal occlusion. Am J Orthod. 1972;62(3):296-309.	503
76	Tay FR, Pashley DH. Aggressiveness of contemporary self-etching systems. I: Depth of penetration beyond dentin smear layers. Dent Mater. 2001;17(4):296-308.	502
77	Gale MS, Darvell BW. Thermal cycling procedures for laboratory testing of dental restorations. J Dent. 1999;27(2):89-99.	497
78	Termine JD, Belcourt AB, Christner PJ, Conn KM, Nylen MU. Properties of dissociatively extracted fetal tooth matrix proteins. I. Principal molecular species in developing bovine enamel. J Biol Chem. 1980;255(20):9760-9768.	496
79	Wilson AD, Kent BE. A new translucent cement for dentistry. The glass ionomer cement. Br Dent J. 1972;132(4):133-135.	495
80	Kosmac T, Oblak C, Jevnikar P, Funduk N, Marion L. The effect of surface grinding and sandblasting on flexural strength and reliability of Y-TZP zirconia ceramic. Dent Mater. 1999;15(6):426-433.	491
81	Miller PD Jr. A classification of marginal tissue recession. Int J Periodontics Restorative Dent. 1985;5(2):8-13.	484
82	Smith BH. Patterns of molar wear in hunger-gatherers and agriculturalists. Am J Phys Anthropol. 1984;63(1):39-56.	483
83	Guazzato M, Albakry M, Ringer SP, Swain MV. Strength, fracture toughness and microstructure of a selection of all-ceramic materials. Part II. Zirconia-based dental ceramics. Dent Mater. 2004;20(5):449-456.	481
84	Kolenbrander PE, Palmer RJ Jr, Periasamy S, Jakubovics NS. Oral multispecies biofilm development and the key role of cell-cell distance. Nat Rev Microbiol. 2010;8(7):471-480.	478
85	Kelly JR, Denry I. Stabilized zirconia as a structural ceramic: an overview. Dent Mater. 2008;24(3):289-298.	476
86	Van Meerbeek B, Inokoshi S, Braem M, Lambrechts P, Vanherle G. Morphological aspects of the resin-dentin interdiffusion zone with different dentin adhesive systems. J Dent Res. 1992;71(8):1530-1540.	475
87	Smith CE. Cellular and chemical events during enamel maturation. Crit Rev Oral Biol Med. 1998;9(2):128-161.	472
88	Li X, Kolltveit KM, Tronstad L, Olsen I. Systemic diseases caused by oral infection. Clin Microbiol Rev. 2000;13(4):547-558.	470
89	Manhart J, Chen H, Hamm G, Hickel R. Buonocore Memorial Lecture. Review of the clinical survival of direct and indirect restorations in posterior teeth of the permanent dentition. Oper Dent. 2004;29(5):481-508.	469
90	Zaura E, Keijser BJ, Huse SM, Crielaard W. Defining the healthy "core microbiome" of oral microbial communities. BMC Microbiol. 2009;9:259.	468

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TABLE 1: Top 200 articles from tooth development to restorative dentistry *(continued)*.

Rank	Article	No. of citations
91	Xu P, Alves JM, Kitten T, Brown A, Chen Z, Ozaki LS, Manque P, Ge X, Serrano MG, Puiu D, Hendricks S, Wang Y, Chaplin MD, Akan D, Paik S, Peterson DL, Macrina FL, Buck GA. Genome of the opportunistic pathogen Streptococcus sanguinis. J Bacteriol. 2007;189(8):3166-3175.	465
92	Hashimoto M, Ohno H, Kaga M, Endo K, Sano H, Oguchi H. In vivo degradation of resin-dentin bonds in humans over 1 to 3 years. J Dent Res. 2000;79(6):1385-1391.	464
93	Davidson CL, Feilzer AJ. Polymerization shrinkage and polymerization shrinkage stress in polymer-based restoratives. J Dent. 1997;25(6):435-440.	463
94	Featherstone JD. The science and practice of caries prevention. J Am Dent Assoc. 2000;131(7):887-899.	459
95	Hunter GK, Hauschka PV, Poole AR, Rosenberg LC, Goldberg HA. Nucleation and inhibition of hydroxyapatite formation by mineralized tissue proteins. Biochem J. 1996;317(Pt 1):59-64.	456
96	Featherstone JD. Prevention and reversal of dental caries: role of low level fluoride. Community Dent Oral Epidemiol. 1999;27(1):31-40.	454
97	Schwartz RS, Robbins JW. Post placement and restoration of endodontically treated teeth: a literature review. J Endod. 2004;30(5):289-301.	453
98	Mitra SB, Wu D, Holmes BN. An application of nanotechnology in advanced dental materials. J Am Dent Assoc. 2003;134(10):1382-1390.	452
99	Ruyter IE, Nilner K, Moller B. Color stability of dental composite resin materials for crown and bridge veneers. Dent Mater. 1987;3(5):246-251.	450
100	Socransky SS, Haffajee AD. Dental biofilms: difficult therapeutic targets. Periodontol 2000. 2002;28:12-55.	448
101	Huang YQ, Wong CK, Zheng JS, Bouwman H, Barra R, Wahlström B, Neretin L, Wong MH. Bisphenol A (BPA) in China: a review of sources, environmental levels, and potential human health impacts. Environ Int. 2012;42:91-99.	446
102	Hammarström L, Heijl L, Gestrelius S. Periodontal regeneration in a buccal dehiscence model in monkeys after application of enamel matrix proteins. J Clin Periodontol. 1997;24(9 Pt 2):669-677.	446
103	Keyes PH. Dental caries in the molar teeth of rats. II. A method for diagnosing and scoring several types of lesions simultaneously. J Dent Res. 1958;37(6):1088-1099.	445
104	Kaufman E, Lamster IB. The diagnostic applications of saliva--a review. Crit Rev Oral Biol Med. 2002;13(2):197-212.	444
105	Thesleff I, Sharpe P. Signalling networks regulating dental development. Mech Dev. 1997;67(2):111-123.	444
106	Barbier O, Arreola-Mendoza L, Del Razo LM. Molecular mechanisms of fluoride toxicity. Chem Biol Interact. 2010;188(2):319-333.	441
107	Heijl L, Heden G, Svärdström G, Ostgren A. Enamel matrix derivative (EMDOGAIN) in the treatment of intrabony periodontal defects. J Clin Periodontol. 1997;24(9 Pt 2):705-714.	439
108	Kolenbrander PE, London J. Adhere today, here tomorrow: oral bacterial adherence. J Bacteriol. 1993;175(11):3247-3252.	439
109	Nolla CM. The development of permanent teeth. J Dent Child. 1960;27:254-266.	435
110	Sheiham A, Watt RG. The common risk factor approach: a rational basis for promoting oral health. Community Dent Oral Epidemiol. 2000;28(6):399-406.	431
111	Thesleff I. Epithelial-mesenchymal signalling regulating tooth morphogenesis. J Cell Sci. 2003;116(Pt 9):1647-1648.	430
112	Smith BG, Knight JK. An index for measuring the wear of teeth. Br Dent J. 1984 23;156(12):435-438.	430
113	Tay FR, Pashley DH, Yoshiyama M. Two modes of nanoleakage expression in single-step adhesives. J Dent Res. 2002;81(7):472-476.	427
114	Nakamichi I, Iwaku M, Fusayama T. Bovine teeth as possible substitutes in the adhesion test. J Dent Res. 1983;62(10):1076-1081.	427
115	Fitzgerald RJ, Keyes PH. Demonstration of the etiologic role of streptococci in experimental caries in the hamster. J Am Dent Assoc. 1960;61(1):9-19.	427
116	Pashley DH, Tay FR, Breschi L, Tjäderhane L, Carvalho RM, Carrilho M, Tezvergil-Mutluay A. State of the art etch-and-rinse adhesives. Dent Mater. 2011;27(1):1-16.	426
117	Tay FR, Pashley DH, Suh BI, Carvalho RM, Itthagarun A. Single-step adhesives are permeable membranes. J Dent. 2002;30(7-8):371-382.	422
118	Sideridou I, Tserki V, Papanastasiou G. Effect of chemical structure on degree of conversion in light-cured dimethacrylate-based dental resins. Biomaterials. 2002;23(8):1819-1829.	422
119	Takahashi N, Nyvad B. The role of bacteria in the caries process: ecological perspectives. J Dent Res. 2011;90(3):294-303.	420
120	Axelsson P, Nyström B, Lindhe J. The long-term effect of a plaque control program on tooth mortality, caries and periodontal disease in adults. Results after 30 years of maintenance. J Clin Periodontol. 2004;31(9):749-757.	417
121	Haywood VB, Heymann HO. Nightguard vital bleaching. Quintessence Int. 1989;20(3):173-176.	417
122	Axelsson P, Lindhe J. Effect of controlled oral hygiene procedures on caries and periodontal disease in adults. J Clin Periodontol. 1978;5(2):133-151.	417
123	De Munck J, Van Meerbeek B, Yoshida Y, Inoue S, Vargas M, Suzuki K, Lambrechts P, Vanherle G. Four-year water degradation of total-etch adhesives bonded to dentin. J Dent Res. 2003;82(2):136-140.	416

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TABLE 1: Top 200 articles from tooth development to restorative dentistry *(continued)*.

Rank	Article	No. of citations
124	Cuy JL, Mann AB, Livi KJ, Teaford MF, Weihs TP. Nanoindentation mapping of the mechanical properties of human molar tooth enamel. Arch Oral Biol. 2002;47(4):281-291.	411
125	Joiner A. The bleaching of teeth: a review of the literature. J Dent. 2006;34(7):412-419.	408
126	Marthaler TM. Changes in dental caries 1953-2003. Caries Res. 2004;38(3):173-81.	407
127	Mina M, Kollar EJ. The induction of odontogenesis in non-dental mesenchyme combined with early murine mandibular arch epithelium. Arch Oral Biol. 1987;32(2):123-127.	406
128	Pashley DH, Carvalho RM. Dentine permeability and dentine adhesion. J Dent. 1997;25(5):355-72.	405
129	Corah NL, Gale EN, Illig SJ. Assessment of a dental anxiety scale. J Am Dent Assoc. 1978;97(5):816-9.	405
130	Ferracane JL. Elution of leachable components from composites. J Oral Rehabil. 1994;21(4):441-452.	404
131	Peters H, Neubüser A, Kratochwil K, Balling R. Pax9-deficient mice lack pharyngeal pouch derivatives and teeth and exhibit craniofacial and limb abnormalities. Genes Dev. 1998;12(17):2735-2747.	403
132	Fincham AG, Moradian-Oldak J, Simmer JP. The structural biology of the developing dental enamel matrix. J Struct Biol. 1999;126(3):270-299.	402
133	Bowen RL. Properties of a silica-reinforced polymer for dental restorations. J Am Dent Assoc. 1963;66(1):57-64.	400
134	Tabak LA, Levine MJ, Mandel ID, Ellison SA. Role of salivary mucins in the protection of the oral cavity. J Oral Pathol. 1982;11(1):1-17.	399
135	Lund JP. Mastication and its control by the brain stem. Crit Rev Oral Biol Med. 1991;2(1):33-64.	398
136	Keijser BJ, Zaura E, Huse SM, van der Vossen JM, Schuren FH, Montijn RC, ten Cate JM, Crielaard W. Pyrosequencing analysis of the oral microflora of healthy adults. J Dent Res. 2008;87(11):1016-1020.	397
137	Ozcan M, Vallittu PK. Effect of surface conditioning methods on the bond strength of luting cement to ceramics. Dent Mater. 2003;19(8):725-731.	397
138	Thylstrup A, Fejerskov O. Clinical appearance of dental fluorosis in permanent teeth in relation to histologic changes. Community Dent Oral Epidemiol. 1978;6(6):315-328.	397
139	Gassner R, Tuli T, Hächl O, Rudisch A, Ulmer H. Cranio-maxillofacial trauma: a 10 year review of 9,543 cases with 21,067 injuries. J Craniomaxillofac Surg. 2003;31(1):51-61.	396
140	Thesleff I, Vaahtokari A, Partanen AM. Regulation of organogenesis. Common molecular mechanisms regulating the development of teeth and other organs. Int J Dev Biol. 1995;39(1):35-50.	395
141	Meenakshi, Maheshwari RC. Fluoride in drinking water and its removal. J Hazard Mater. 2006;137(1):456-63.	394
142	Ferracane JL, Berge HX, Condon JR. In vitro aging of dental composites in water--effect of degree of conversion, filler volume, and filler/matrix coupling. J Biomed Mater Res. 1998;42(3):465-472.	394
143	van den Boogaard MJ, Dorland M, Beemer FA, van Amstel HK. MSX1 mutation is associated with orofacial clefting and tooth agenesis in humans. Nat Genet. 2000;24(4):342-343.	393
144	Kinney JH, Marshall SJ, Marshall GW. The mechanical properties of human dentin: a critical review and re-evaluation of the dental literature. Crit Rev Oral Biol Med. 2003;14(1):13-29.	392
145	Greene JC, Vermillion JR. The oral hygiene index: a method for classifying oral hygiene status. J Am Dent Assoc. 1960;61(2):172-179.	392
146	Wiegand A, Buchalla W, Attin T. Review on fluoride-releasing restorative materials--fluoride release and uptake characteristics, antibacterial activity and influence on caries formation. Dent Mater. 2007;23(3):343-362.	391
147	Moszner N, Salz U, Zimmermann J. Chemical aspects of self-etching enamel-dentin adhesives: a systematic review. Dent Mater. 2005;21(10):895-910.	389
148	Ferracane JL. Correlation between hardness and degree of conversion during the setting reaction of unfilled dental restorative resins. Dent Mater. 1985;1(1):11-4.	389
149	Pashley DH, Sano H, Ciucchi B, Yoshiyama M, Carvalho RM. Adhesion testing of dentin bonding agents: a review. Dent Mater. 1995;11(2):117-125.	388
150	Van Meerbeek B, Perdigão J, Lambrechts P, Vanherle G. The clinical performance of adhesives. J Dent. 1998;26(1):1-20.	387
151	Keller U, Hibst R. Experimental studies of the application of the Er:YAG laser on dental hard substances: II. Light microscopic and SEM investigations. Lasers Surg Med. 1989;9(4):345-351.	387
152	Pashley DH, Carvalho RM, Sano H, Nakajima M, Yoshiyama M, Shono Y, Fernandes CA, Tay F. The microtensile bond test: a review. J Adhes Dent. 1999;1(4):299-309.	386
153	Goodman AH, Rose JC. Assessment of systemic physiological perturbations from dental enamel hypoplasias and associated histological structures. Yearb Phys Anthropol. 1990;33(S11):59-110.	386
154	Kleinknecht RA, Klepac RK, Alexander LD. Origins and characteristics of fear of dentistry. J Am Dent Assoc. 1973;86(4):842-848.	386
155	Van Noort R, Noroozi S, Howard IC, Cardew G. A critique of bond strength measurements. J Dent. 1989;17(2):61-67.	385
156	Pashley DH, Tay FR. Aggressiveness of contemporary self-etching adhesives. Part II: etching effects on unground enamel. Dent Mater. 2001;17(5):430-444.	383

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TABLE 1: Top 200 articles from tooth development to restorative dentistry *(continued)*.

Rank	Article	No. of citations
157	Ou CY, Ciesielski CA, Myers G, Bandea CI, Luo CC, Korber BT, Mullins JI, Schochetman G, Berkelman RL, Economou AN, Witte JJ, Furman LJ, Satten GA, MacInnes KA, Curran JV, Jaffe HW, Moore J, Villamarzo Y, Schable C, Shpaer EG, Liberti T, Lieb S, Scott R, Howell J, Dumbaugh R, Lasch A, Kroesen B, Ryan L, Bell K, Munn V, Marianos D, Gooch B. Molecular epidemiology of HIV transmission in a dental practice. Science. 1992;256(5060):1165-1171.	382
158	Thesleff I, Hurmerinta K. Tissue interactions in tooth development. Differentiation. 1981;18(2):75-88.	382
159	Aas JA, Griffen AL, Dardis SR, Lee AM, Olsen I, Dewhirst FE, Leys EJ, Paster BJ. Bacteria of dental caries in primary and permanent teeth in children and young adults. J Clin Microbiol. 2008;46(4):1407-17.	381
160	Tyas MJ, Anusavice KJ, Frencken JE, Mount GJ. Minimal intervention dentistry--a review. FDI Commission Project 1-97. Int Dent J. 2000;50(1):1-12.	380
161	Mandel ID. The functions of saliva. J Dent Res. 1987;66(Spec Iss):623-627.	380
162	Lammi L, Arte S, Somer M, Jarvinen H, Lahermo P, Thesleff I, Pirinen S, Nieminen P. Mutations in AXIN2 cause familial tooth agenesis and predispose to colorectal cancer. Am J Hum Genet. 2004;74(5):1043-1050.	379
163	Labella R, Lambrechts P, Van Meerbeek B, Vanherle G. Polymerization shrinkage and elasticity of flowable composites and filled adhesives. Dent Mater. 1999;15(2):128-37.	379
164	Bayne SC, Thompson JY, Swift EJ Jr, Stamatiades P, Wilkerson M. A characterization of first-generation flowable composites. J Am Dent Assoc. 1998;129(5):567-577.	379
165	Fox PC, van der Ven PF, Sonies BC, Weiffenbach JM, Baum BJ. Xerostomia: evaluation of a symptom with increasing significance. J Am Dent Assoc. 1985;110(4):519-25.	379
166	Harada H, Kettunen P, Jung HS, Mustonen T, Wang YA, Thesleff I. Localization of putative stem cells in dental epithelium and their association with Notch and FGF signaling. J Cell Biol. 1999;147(1):105-120.	378
167	New PF, Rosen BR, Brady TJ, Buonanno FS, Kistler JP, Burt CT, Hinshaw WS, Newhouse JH, Pohost GM, Taveras JM. Potential hazards and artifacts of ferromagnetic and nonferromagnetic surgical and dental materials and devices in nuclear magnetic resonance imaging. Radiology. 1983;147(1):139-148.	378
168	Chen T, Yu WH, Izard J, Baranova OV, Lakshmanan A, Dewhirst FE. The Human Oral Microbiome Database: a web accessible resource for investigating oral microbe taxonomic and genomic information. Database (Oxford). 2010;2010:baq013.	377
169	ten Cate JM, Duijsters PP. Alternating demineralization and remineralization of artificial enamel lesions. Caries Res. 1982;16(3):201-210.	377
170	Bowen WH, Koo H. Biology of Streptococcus mutans-derived glucosyltransferases: role in extracellular matrix formation of cariogenic biofilms. Caries Res. 2011;45(1):69-86.	376
171	Kawashita M, Tsuneyama S, Miyaji F, Kokubo T, Kozuka H, Yamamoto K.Antibacterial silver-containing silica glass prepared by sol-gel method. Biomaterials. 2000;21(4):393-398.	374
172	van Houte J. Role of micro-organisms in caries etiology. J Dent Res. 1994;73(3):672-681.	374
173	Caufield PW, Cutter GR, Dasanayake AP. Initial acquisition of mutans streptococci by infants: evidence for a discrete window of infectivity. J Dent Res. 1993;72(1):37-45.	374
174	Davidson CL, de Gee AJ. Relaxation of polymerization contraction stresses by flow in dental composites. J Dent Res. 1984;63(2):146-148.	374
175	Weinmann W, Thalacker C, Guggenberger R. Siloranes in dental composites. Dent Mater. 2005;21(1):68-74.	373
176	MacDougall M, Simmons D, Luan X, Nydegger J, Feng J, Gu TT. Dentin phosphoprotein and dentin sialoprotein are cleavage products expressed from a single transcript coded by a gene on human chromosome 4. Dentin phosphoprotein DNA sequence determination. J Biol Chem. 1997;272(2):835-842.	372
177	Konopka K, Goslinski T. Photodynamic therapy in dentistry. J Dent Res. 2007;86(8):694-707.	371
178	Tjäderhane L, Larjava H, Sorsa T, Uitto VJ, Larmas M, Salo T. The activation and function of host matrix metalloproteinases in dentin matrix breakdown in caries lesions. J Dent Res. 1998;77(8):1622-1629.	369
179	Ito S, Hashimoto M, Wadgaonkar B, Svizero N, Carvalho RM, Yiu C, Rueggeberg FA, Foulger S, Saito T, Nishitani Y, Yoshiyama M, Tay FR, Pashley DH. Effects of resin hydrophilicity on water sorption and changes in modulus of elasticity. Biomaterials. 2005 Nov;26(33):6449-59.	368
180	Potera C. Microbiology-Forging a link between biofilms and disease. Science. 1999;283(5409):1837-1839.	366
181	Rickard AH, Gilbert P, High NJ, Kolenbrander PE, Handley PS. Bacterial coaggregation: an integral process in the development of multi-species biofilms. Trends Microbiol. 2003;11(2):94-100.	365
182	Sano H, Yoshikawa T, Pereira PN, Kanemura N, Morigami M, Tagami J, Pashley DH. Long-term durability of dentin bonds made with a self-etching primer, in vivo. J Dent Res. 1999;78(4):906-911.	365
183	Bouillaguet S, Troesch S, Wataha JC, Krejci I, Meyer JM, Pashley DH. Microtensile bond strength between adhesive cements and root canal dentin. Dent Mater. 2003;19(3):199-205	364

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TABLE 1: Top 200 articles from tooth development to restorative dentistry *(continued)*.

Rank	Article	No. of citations
184	Qiu M, Bulfone A, Ghattas I, Meneses JJ, Christensen L, Sharpe PT, Presley R, Pedersen RA, Rubenstein JL. Role of the Dlx homeobox genes in proximodistal patterning of the branchial arches: mutations of Dlx-1, Dlx-2, and Dlx-1 and -2 alter morphogenesis of proximal skeletal and soft tissue structures derived from the first and second arches. Dev Biol. 1997 May 15;185(2):165-184.	364
185	Chai Y, Maxson RE Jr. Recent advances in craniofacial morphogenesis. Dev Dyn. 2006;235(9):2353-2375.	362
186	Xu HH, Smith DT, Jahanmir S, Romberg E, Kelly JR, Thompson VP, Rekow ED. Indentation damage and mechanical properties of human enamel and dentin. J Dent Res. 1998;77(3):472-480.	361
187	Pashley DH, Ciucchi B, Sano H, Horner JA. Permeability of dentin to adhesive agents.Quintessence Int. 1993;24(9):618-631.	360
188	Jacobsen T, Söderholm KJ. Some effects of water on dentin bonding. Dent Mater. 1995;11(2):132-136.	358
189	Bagramian RA, Garcia-Godoy F, Volpe AR. The global increase in dental caries. A pending public health crisis. Am J Dent. 2009;22(1):3-8.	357
190	Helkimo E, Carlsson GE, Helkimo M. Bite force and state of dentition. Acta Odontol Scand. 1977;35(6):297-303.	357
191	Wade WG. The oral microbiome in health and disease. Pharmacol Res. 2013;69(1):137-143.	356
192	Demarco FF, Corrêa MB, Cenci MS, Moraes RR, Opdam NJ. Longevity of posterior composite restorations: not only a matter of materials. Dent Mater. 2012;28(1):87-101.	356
193	Rueggeberg FA, Caughman WF, Curtis JW Jr. Effect of light intensity and exposure duration on cure of resin composite. Oper Dent. 1994;19(1):26-32.	356
194	Greenberg JH, Turner CG, Zegura SL. The Settlement of the Americas: A Comparison of the Linguistic, Dental, and Genetic Evidence. Curr. Anthropol. 1986;27(5): 477-497.	356
195	Ryge G. Clinical criteria. Int Dent J. 1980;30(4):347-358.	355
196	Kolenbrander PE, Palmer RJ Jr, Rickard AH, Jakubovics NS, Chalmers NI, Diaz PI. Bacterial interactions and successions during plaque development. Periodontol 2000. 2006;42:47-79.	354
197	Stockton DW, Das P, Goldenberg M, D'Souza RN, Patel PI. Mutation of PAX9 is associated with oligodontia. Nat Genet. 2000;24(1):18-19.	354
198	Linde A, Goldberg M. Dentinogenesis. Crit Rev Oral Biol Med. 1993;4(5):679-728.	353
199	Featherstone JD, ten Cate JM, Shariati M, Arends J. Comparison of artificial caries-like lesions by quantitative microradiography and microhardness profiles. Caries Res. 1983;17(5):385-391.	352
200	De Munck J, Vargas M, Van Landuyt K, Hikita K, Lambrechts P, Van Meerbeek B. Bonding of an auto-adhesive luting material to enamel and dentin. Dent Mater. 2004;20(10):963-971.	351

TABLE 2: Journals containing three or more top-cited articles.

Journal name	Abbreviated name	Impact factor	No of articles
Journal of Dental Research (Critical Reviews in Oral Biology& Medicine now included Journal of Dental Research)	J Dent Res (Crit Rev Oral Biol M)	5,125	33
Dental Materials	Dent Mater	4,440	26
Journal of The American Dental Association	J Am Dent Assoc	2,572	11
Journal of Dentistry	J Dent	3,280	8
Community Dentistry and Oral Epidemiology	Community Dent Oral Epidemiol	2,278	7
Journal of Clinical Periodontology	J Clin Periodontol	4,164	6
Biomaterials	Biomaterials	10,273	4
Caries Research	Caries Res	2,326	4
Operative Dentistry	Oper Dent	2,027	4
Archives of Oral Biology	Arch Oral Biol	1,663	3
British Dental Journal	Br DentJ	1,438	3
Journal of Bacteriology	J Bacteriol	3,234	3
Nature Genetics	Nat Genet	25,455	3
Journal of Periodontology	J Periodontol	2,768	3
Science	Science	41,037	3

All articles obtained from three separate lists were combined in a single list. After the articles were ranked from highest to lowest by the number of citations, the titles were read by two independent researchers, and if necessary, abstracts were then read sequentially to identify the nominee articles for a review of all of text.[16] The most cited 200 articles were selected based on the topics which we had previously determined from journals, textbooks and curriculum of operative dentistry, and a comparison was made to check the duplicates (Table 3).

Later, the number of citations was used to sort the end list in a descending order. Accordingly, concerning articles with a similar number of references, the more current one was ranked higher. Following the confirmation of the final list, the full text of each of the 200 articles was collected. Then, the top 200 most-cited articles were analyzed by two researchers

TABLE 3: Numbers of the top-cited articles categorized on basis of type and specific field.

Field of study	Type of study					
	Clinical	Basic	Review	News	Guideline	Index
Enamel structure and/or properties		2	1			
Dentin structure and/or properties		4	5			
Cementum ultrastructure			1			
Dental caries and/or dental plaque	14	15	31	1	1	1
Dental erosion			2			
Dental care (oral health)	1					
Bonding to enamel		6	6			
Bonding to dentin		17	10			
Dental amalgam		1	2			
Dental materials/dentin adhesives	1	2	5			
Dental materials/composites	1	15	4			
Dental materials/polymers		1	3			
Cements		2	1			
Ceramics		2	1			
Sealant		2	1			
Thermal cycling			1			
Tooth development (odontogenesis)	2	12	12			
Tooth abnormalities		5	1			
Surface Roughness effect on plaque formation			3			
Mastication/bite force	1		1			
Teeth morphology			1			
Pulp reactions		2				
Saliva	1		5			
Flour and/or Fluorosis	1		5			
Hydrogen peroxide metabolism			1			
Laser application		2				
Resin-ceramic bonding		2	1			
Dental occlusion					1	
Marginal tissue recession					1	
Tooth wear		1				1
Restoration of endodontically treated teeth			1			
Tooth bleaching			1		1	
Dental anxiety/fear	1		1			
Tooth injuries (Trauma)/epidemiology	1		1			
HIV transmission		1				
Minimal intervention dentistry			1			
Dental restorations	1				1	

related to the number of citations, publication name (title), journal name, author(s) (name, number, authorship position, institution, country), year of publication, institutional collaboration type, type of study, study design of clinical articles and thematic field and level of evidence of study.

The VOSviewer (version 1.6.15), a software tool used to analyze bibliometric data, was used to create a collaborative network among authors. The country and institution of origin was determined by the address declared by the first author. In addition, regardless of their departments, the institutions and the addresses of co-authors were also considered to detect institutional collaboration type. Thus, institutional collaboration type was determined as "individual institution" if all contributing authors were from the same research institution, as "international collaborations" if there were institutes from different countries and as "multi-institutional collaboration" if multiple institutions within the same country joined the study.[13,16] Type of study was determined as clinical, basic, review, news, guideline, and index according to types of articles. A study classified as a basic study which included experiments on extracted human teeth, animal, dental plaque, microorganism, saliva, dental materials or cells.[13] Two authors (MD, FK) read the full texts on the list and summarized them respectively to describe the fields of the studies. Then, the summary sheet was concluded with mutual consensus.[14] The previously described study designs were used as follows: a randomized controlled trial, a systematic review of randomized controlled trial, a non-randomized experimental study, a systematic review of cross-sectional study among consecutive presenting patients, cross-sectional study among consecutive presenting patients, cross-sectional study among non-consecutive patients, cross sectional study, case report with the level of evidence (I, II, III and IV) based on the type of research question (intervention1, diagnosis, prognosis and etiology), and case-control study.[17] The field of study included topics from odontogenesis to disease and restorative treatment (Table 3). While determining the field of the study, the full text of each article was carefully reviewed. In addition, an abstract of each study in PubMed was accessed and the Medical Subject Headings (MeSH terms) given for this study field were considered. Statistical analysis of frequency of descriptive measures was performed using SPSS version 21 (IBM Corp, Armonk, NY, USA).

RESULTS

The top 200 articles which were most cited based the number of citations are shown Table 1 in a descending order. The most cited article had 2,532 citations and it was a review of the extracellular matrix metalloproteinase published in 1993 by Birkedal-Hansen et al. in the journal of Critical Reviews in Oral Biology and Medicine (Table 1). The least cited article got 351 citations. The top 200 most-cited articles had a total of 112,616 citations and the mean number of citations was 563 for each article.

JOURNALS AND YEARS OF PUBLICATION

The top-cited 200 articles were published in 78 different journals, all in English language. In 47 of these journals, only one top article was published, and two top articles in 16 of them. Fifteen journals published at least three of the top-cited articles (Table 2). Impact factor of these 15 journals were between 1,438 and 41,037. "Journal of Dental Research" (n=33) published the highest number of top-cited articles, and it was followed by "Dental Materials" (n=26) and "Journal of The American Dental Association" (n=11).

These top 200 articles,which were most cited, were published between 1954 and 2012. Twenty-one of these were published before 1975, 37 between 1976 and 1990, 64 between 1991 and 2000, 69 between 2001 and 2010, and 9 after 2011. The years 2000 and 2003 were the years with the highest number of top-cited articles (n=13), and they were followed by the years 1997 (n=12), 2002 (n=10), 1999 and 2004 (n=9), and 1998 and 2005 (n=8). The oldest article was written by Gustafsson et al. and published in "Acta Odontologica Scandinavica" in 1954. The newest articles were written by Hui et al., Marcenes et al., and Wade, and were published in "Angle Orthodontist", "Journal of Dental Research" and "Pharmacological Research", respectively, in 2013 (Table 1).

AUTHORS, COUNTRIES, AND INSTITUTIONS OF ORIGIN

A total of 607 unique authors were included in the 200 most-cited articles. The number of authors of

the top cited articles was between 1 and 32. Thirty-four articles belonged to a single author, 50 articles to two authors, 38 articles to three authors, 16 articles to four and 17 articles to five authors. DH Pashley (15 articles; 6,513 citations) published the articles with the highest number of citations, and he was followed by B Van Meerbeek (11 articles; 6,610 citations) and P Lambrechts (10 articles; 6,036 citations) (Figure 1).

The top 200 most-cited articles were written in 25 countries based the countries of origin which reflected the address of the first author. The United States was the country with the highest number of articles (98 articles; 58,304 citations) and approximately half of the top cited articles were prepared in the United States (Figure 2). This was followed by Belgium with 13 articles (7,705 citations), Japan with 11 articles (5,770 citations), Netherlands with 10 articles (4,772 citations) and United Kingdom with 10 articles (4,509 citations).

In total, 117 institutions defined with the address of the first author contributed the top-cited 200 articles. The number of institutions with three or more articles is 20 (Table 4). Among the 20 institutions, the Catholic University of Leuven was the institution with the highest number of articles contributed with 13 articles (7,705 citations), and it was followed by National Institutes of Health with 10 articles (2,817 citations), Medical College of Georgia with 8 articles (3,307 citations) and University of Helsinki with 7 articles (3,122). Considering all the authors that contributed to an article, we found that a single institution was included in the preparation of 114 articles, while 31 articles were prepared by multi-institutional collaboration within the same country and 55 articles by international collaborations.

TYPE, FIELD AND STUDY DESIGN, LEVEL OF EVIDENCE AND TYPE OF RESEARCH QUESTION OF THE CLINICAL ARTICLES

Among 200 top-cited articles; basic science research had the highest number of articles with 87 articles. Eighty-six articles focused on reviews, 24 articles declared clinical trial, 5 articles were guideline, 2 articles were index, and one study was news (Table 3).

Main topics of the top 87 most-cited basic science articles were bonding to dentin with 17 articles, followed by dental caries and/or dental plaque with 15 articles and dental materials/composites with 15 articles. Main topics of the top 86 most-cited review

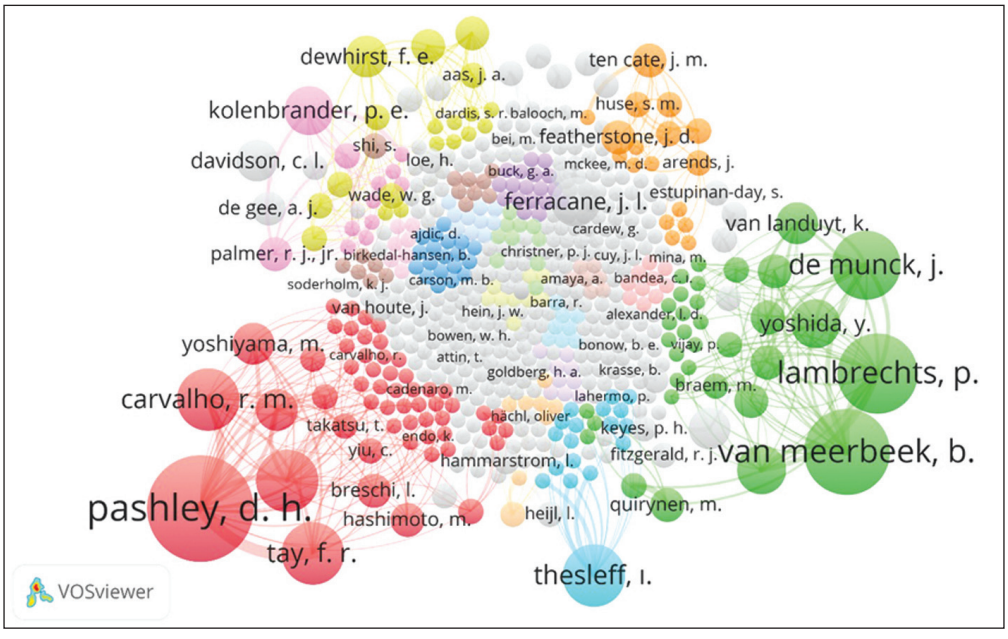

FIGURE 1: A co-authorship map shows all the contributor authors of the 200 top-cited articles (n=607). From VOSviever interface; in analysis option "LinLog/modularity" selected as normalization method and in the 'Weights' drop-down list from Visualization section, 'Documents' option was selected to determine the label sizes of the authors depending on the number of articles to which they contributed.

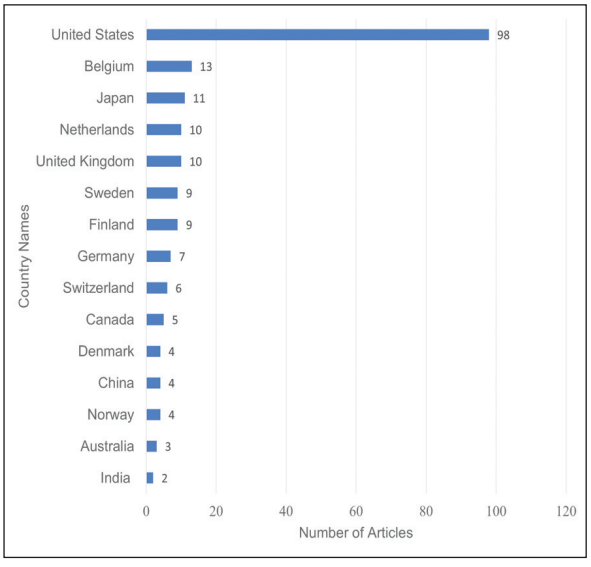

FIGURE 2: Countries of origin with 2 or more the top-cited 200 articles.

articles were dental caries and/or dental plaque with 31 articles, followed by odontogenesis with 12 articles and bonding to dentin with 10 articles. Main topics in the top 24 most-cited clinical trial articles were dental caries and/or dental plaque with 14 articles, followed by odontogenesis with 2 articles (Table 3). The most common study design in clinical trial articles was cross-sectional studies among non-consecutive patients with 6 articles. The most frequent research question type was classified as intervention with 11 articles. Level of evidence was classified as having level III in 9 articles and level II in 7 articles (Table 5).

DISCUSSION

In agreement with the results of other studies, we found that 95.5% (192 articles) of top cited articles were published before 2010.[9,11,13-16,18-22] In contrast, some studies have reported that the articles which are the most-cited ones have been published in the last 10 years.[9,15,18] The oldest articles usually have a longer period of time to be cited than newer articles, regardless of their scientific impact, and thus this risks excluding most recent influential articles.[21] A minimum publication period of 6 to 15 years is required for an article to get cited ata sufficient number and become a classic for citations.[19] This could explain why the

TABLE 4: Institutions of origin with three or more top-cited articles.

Rank	Institution	No. of articles
1	Catholic University of Leuven	13
2	National Institutes of Health	10
3	Medical College of Georgia	8
4	University of Helsinki	7
5	University of Amsterdam	5
6	University of California	5
7	University of Michigan	5
8	Oregon Health Sciences University	4
9	The Forsyth Institute	4
10	Tokyo Medical and Dental University	4
11	University of Southern California	4
12	Harvard Medical School	3
13	Hokkaido University	3
14	State University of New York	3
15	The Royal Dental College	3
16	University of Gothenburg	3
17	University of North Carolina	3
18	University of Oslo	3
19	University of Rochester	3
20	WHO Global Oral Health Program, World Health Organization	3

TABLE 5: Study design, level of evidence and type of research question of the clinical articles in top 200.

Study design	Level of evidence	Type of research question	Number of articles
Randomized controlled trial	II	Intervention	5
Systematic review of randomized controlled trial	I	Intervention	3
Non-randomized experimental study	III	Intervention	3
Systematic review of cross-sectional study among consecutive presenting patients	I	Diagnosis	1
Cross-sectional study among consecutive presenting patients	II	Diagnosis	2
Cross-sectional study among non-consecutive patients	III	Diagnosis	6
Cross sectional study	IV	Aetiology	1
Case-control study	III	Aetiology	2
Case report	-	Not applicable	1

200 most cited lists do not contain articles published in the past 5 years.There is a tendency to adhere to a paradigm in a scientific community, according to Kuhnian philosophy. It means a 'snowball effect' for citations, as other authors are more likely to cite it under the influence of previous citations rather than its content or quality.[24,25] On the other hand, when an article is cited more than 400 times, it should be considered classic; however, 100 citations may deem a work qualified in some fields with fewer researchers.[26] In the present study, the first 133 articles got cited more than 400 times and 200th article was cited 351 times. And therefore, this would not only the snowball effect but also the content or quality of article effected its citation rate.

It is known that high-impact journals are usually chosen by researchers for manuscript submission and that journals with high impact factors (IFs) attract high-quality papers.[21] However, no significant association has been found between the impact factor of a journal and the number of top-cited articles.[16,22] On the other hand, it has been reported previously that there has been a close relationship between the number of citations and relevant impact in a limited number of journals, especially in the fields with high-citation density.[3,20] This may be attributed to that most highly cited articles have high probabilityto be published in journals with high IFs.[6] The average impact factor of 91 journals in the "Web of Science Group Master Journal List" with filtering "Science Index Expanded" and "Dentistry Oral Surgery & Medicine" is 1,878. Also, journals with an impact factor of 3 or more constitute about 11%. In our study, more than half of the top 200 most-cited articles (114 articles) were published in the journals with an impact factor of >2 which included 3 or more articles that were top-cited. Besides, 73 of 114 articles were published in the journals with relatively high IFs (3 or more) in the field of dentistry. This finding was in agreement with other studies.[3,6,20] In addition, more than one third of the articles were published in the journals with specialty which also included topics of our study, and this result may provide justification to why fewer journals received greater attention and dominated the literature of odontogenesis to treatment in operative dentistry and related multidisciplinary fields.[22] Thus, this finding is in accordance with Bradford's Laws which explained that in a subject field, there are a few journals that are the most frequently cited and are therefore likely to be of highest interest to researchers in the discipline.[15,27,28]

In the present study, it was revealed that almost half of top-cited 200 articles (98 articles) originated from USA with respect to institutions and origin of country. Also, the results of the present study are consistent with other studies.[8,11,16,19,22,23,29] This can be attributed to the high numbers of institutions, research center and researchers, and adequate budgets for scientific investigation.[8,11,16,19,22,23,29] In agreement with other studies, although the United States was the leading country in terms of the number of highly cited publications related to dentistry, it was found an increasing number of highly cited publications (72 articles) by authors residing in Europe.[6,19] This situation goes along with the phenomenon that the higher economic ranking of a country enables it to produce the higher quantity and quality of biomedical publications.[22,30]

The most-cited articles in this study were originated from Catholic University of Leuven (13 articles) during the period of 1992-2011, followed by National Institutes of Health (10 articles) between 1958-2010 and Medical College of Georgia (8 articles) between 1993-2011. Catholic University of Leuven and Medical College of Georgia concerned the subspecialty of dental adhesion, and National Institutes of Health concerned the subspecialty of caries /dental plaque microbiology. Even though almost half of top-cited 200 articles prepared in the institutions in the USA, the most-cited articles were from Belgium (Catholic University of Leuven). Despite the small population of Belgium, researchers in this country have been comparatively highly active in publications during the study period.[23,31] This finding was in accordance with another finding of our study which showed that the researchers in this center had two or more top cited articles (Figure 1). Similar to our findings, other studies found that research groups from Scandinavian countries made considerable contribution to top cited articles of different dentistry fields in their studies.[23,31]

In this bibliometric research, the top-cited articles were basic research (87 articles), followed by reviews (86 articles) and clinical trial (24 articles). Other

studies reported that most of the articles which were top-cited were in the field of basic or clinical sciences.[3,8,13,14,16,19,21] However, in a study, it was suggested that most of top cited articles were reviews.[32] This large number of reviews shows that many researchers have an inclination to compile the existing data and knowledge in the subspecialty varying from odontogenesis to treatment of operative dentistry for the benefits of readers.[32] Besides, reviews are especially useful for the development of scholarships because they give researchers an overview of the currently available evidence.[33] Also, it can be assumed that a common feature of highly cited reviews is the lead authors of these reviews who have specialty with significant and identifiable level of expertise on the subject matter.[34] In agreement with this assumption, all the authors who had two or more top cited articles had one or more reviews in our study (except four authors). In our study, the number of review and basic science studies were approximately equal. Basic research in the subspecialty varying from odontogenesis to treatment of operative dentistry is especially important to provide the effectiveness of new materials or modified techniques.[13] In vitro studies are uniquely important in developing procedures and provide preliminary data on which subsequent studies with higher amount of evidence can be designed.[18]

In our study, 24 articles, which were top cited, were in the field of clinical trial. In accordance with the findings of reviews and basic sciences, the majority of the articles on clinical trial were in subspecialty of dental caries and/or dental plaque subspecialty (14 articles). The most common study designs in clinical trial articles were cross-sectional studies (6 articles), followed by randomized controlled trials (5 articles). Level of evidence was III at most (9 articles), followed by II (7 articles). In accordance with our findings, the cross-sectional study was reported to be the most common study design, however contrary to our results, case series or case reports was reported as the most common clinical study design.[3,12-15,18] It was reported that majority of top cited clinical trial articles had level III evidence.[16] However, other studies found low-level evidence such as IV or V.[13,14,19,21] It has been stated that dental scientists ought to have the ability to identify, criticize and categorize the literature, and classify it into a so-called hierarchy of evidence, with systematic reviews and meta-analyses of randomized controlled trials (RCTs) at the top contributing to the highest level of evidence, followed by RCTs, non-RCTs, cohort studies, case-control studies, crossover studies, cross-sectional studies, case studies, and expert opinions and uncontrolled studies or opinion at the bottom.[6,17,35]

CONCLUSION

A total of 95.5% of top-cited articles had been published before 2010. Almost half of the 200 articles which were top-cited were prepared in the USA. The most top-cited articles were prepared by Catholic University of Leuven. Most of the top-cited articles were basic research, followed by reviews and clinical trial. The most basic researches were concerned with bonding to dentin. Whereas major topic of review and clinical trial articles were by dental caries and/or dental plaque. The study design which was the most commonly used in clinical trial articles was cross-sectional study followed by randomized controlled trials. Level of evidence was III at most. Thus, high level of evidence studies such as meta-analyses, systematic review, or randomized controlled trial may be needed in the future.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Mustafa Demirci, Safa Tuncer;* ***Design:*** *Mustafa Demirci, Ferda Karabay;* ***Control/Supervision:*** *Mustafa Demirci;* ***Data Collection and/or Processing:*** *Ferda Karabay, Meriç Berkman;* ***Analysis and/or Interpretation:*** *Ferda Karabay, Meriç Berkman;* ***Writing the Article:*** *Mustafa Demirci, Ferda Karabay;* ***Critical Review:*** *Safa Tuncer, Neslihan Tekçe.*

REFERENCES

1. Moed HF. New developments in the use of citation analysis in research evaluation. Arch Immunol Ther Exp (Warsz). 2009;57(1):13-8. [Crossref] [PubMed]
2. Azer SA. Top-Cited Articles in Problem-Based Learning: A Bibliometric Analysis and Quality of Evidence Assessment. J Dent Educ. 2017;81(4):458-78. [Crossref] [PubMed]
3. Feijoo JF, Limeres J, Fernández-Varela M, Ramos I, Diz P. The 100 most cited articles in dentistry. Clin Oral Investig. 2014;18(3):699-706. [Crossref] [PubMed]
4. Huang Y, Zhu D, Lv Q, Porter AL, Robinson DKR, Wang X. Early insights on the Emerging Sources Citation Index (ESCI): an overlay map-based bibliometric study. Scientometrics. 2017;111:2041-57. [Crossref]
5. Web of Science [Internet]. [Cited: 30 May 2020]. Web of Science platform: Web of Science: Summary of Coverage. Available from: [Link]
6. Gogos C, Kodonas K, Fardi A, Economides N. Top 100 cited systematic reviews and meta-analyses in dentistry. Acta Odontol Scand. 2020;78(2):87-97. [Crossref] [PubMed]
7. Jayaratne YS, Zwahlen RA. The evolution of dental journals from 2003 to 2012: a bibliometric analysis. PLoS One. 2015;10(3): e0119503. [Crossref] [PubMed] [PMC]
8. Ahmad P, Alam MK, Jakubovics NS, Schwendicke F, Asif JA. 100 Years of the Journal of Dental Research: A Bibliometric Analysis. J Dent Res. 2019;98(13):1425-36. [Crossref] [PubMed]
9. Ahmad P, Dummer PMH, Chaudhry A, Rashid U, Saif S, Asif JA. A bibliometric study of the top 100 most-cited randomized controlled trials, systematic reviews and meta-analyses published in endodontic journals. Int Endod J. 2019;52(9):1297-316. [Crossref] [PubMed]
10. Gonçalves AP, Plá AL, Rodolfo B, Nahsan FP, Correa MB, Moraes RR. Top-100 Most Cited Dental Articles with Authors from Brazil. Braz Dent J. 2019;30(2):96-105. [Crossref] [PubMed]
11. Ahmad P, Asif JA, Alam MK, Slots J. A bibliometric analysis of Periodontology 2000. Periodontol 2000. 2020;82(1):286-97. [Crossref] [PubMed]
12. Alarcón MA, Esparza D, Montoya C, Monje A, Faggion CM Jr. The 300 Most-Cited Articles in Implant Dentistry. Int J Oral Maxillofac Implants. 2017;32(1):e1-e8. [Crossref] [PubMed]
13. Fardi A, Kodonas K, Gogos C, Economides N. Top-cited articles in endodontic journals. J Endod. 2011;37(9):1183-90. [Crossref] [PubMed]
14. Hui J, Han Z, Geng G, Yan W, Shao P. The 100 top-cited articles in orthodontics from 1975 to 2011. Angle Orthod. 2013;83(3):491-9. [Crossref] [PubMed] [PMC]
15. Perazzo MF, Otoni ALC, Costa MS, Granville-Granville AF, Paiva SM, Martins-Júnior PA. The top 100 most-cited papers in Paediatric Dentistry journals: A bibliometric analysis. Int J Paediatr Dent. 2019;29(6):692-711. [Crossref] [PubMed]
16. Yılmaz B, Dinçol ME, Yalçın TY. A bibliometric analysis of the 103 top-cited articles in endodontics. Acta Odontol Scand. 2019;77(8):574-83. [Crossref] [PubMed]
17. Glasziou PP, Del Mar C, Salisbury J. Evidence-based practice workbook : bridging the gap between health care research and practice. Malden, MA: John Wiley & Sons; 2009. [Link]
18. Adnan S, Ullah R. Top-cited Articles in Regenerative Endodontics: A Bibliometric Analysis. J Endod. 2018;44(11):1650-64. [Crossref] [PubMed]
19. Fardi A, Kodonas K, Lillis T, Veis A. Top-Cited Articles in Implant Dentistry. Int J Oral Maxillofac Implants. 2017;32(3):555-64. [Crossref] [PubMed]
20. Chiang HS, Huang RY, Weng PW, Mau LP, Su CC, Tsai YC, et al. Increasing prominence of implantology research: a chronological trend analysis of 100 top-cited articles in periodontal journals. Eur J Oral Implantol. 2018;11(1):97-110. [PubMed]
21. Gondivkar SM, Sarode SC, Gadbail AR, Gondivkar RS, Chole R, Sarode GS. Bibliometric analysis of 100 most cited articles on oral submucous fibrosis. J Oral Pathol Med. 2018;47(8):781-7. [Crossref] [PubMed]
22. Gondivkar SM, Sarode SC, Gadbail AR, Gondivkar RS, Choudhary N, Patil S. Citation Classics in Cone Beam Computed Tomography: The 100 Top-Cited Articles. Int J Dent. 2018;2018:9423281. [Crossref] [PubMed] [PMC]
23. Jafarzadeh H, Sarraf Shirazi A, Andersson L. The most-cited articles in dental, oral, and maxillofacial traumatology during 64 years. Dent Traumatol. 2015;31(5):350-60. [Crossref] [PubMed]
24. Kuhn TS. Historical structure of scientific discovery. Science. 1962;136(3518):760-4. [Crossref] [PubMed]
25. Lefaivre KA, Shadgan B, O'Brien PJ. 100 most cited articles in orthopaedic surgery. Clin Orthop Relat Res. 2011;469(5):1487-97. [Crossref] [PubMed] [PMC]
26. Citation Classics [Internet]. [Cited: 30 May 2020]. Short History of Citation Classics Commentaries. Available from: [Link]
27. Bradford SC. Sources of information on specific subjects. Engineering 1934;137:85-86. [Link]
28. Potter J. Mapping the literature of occupational therapy: an update. J Med Libr Assoc. 2010;98(3):235-42. [Crossref] [PubMed] [PMC]
29. Yeung AWK, Leung WK. Citation Network Analysis of Dental Implant Literature from 2007 to 2016. Int J Oral Maxillofac Implants. 2018;33(6):1240-6. [Crossref] [PubMed]
30. Nielsen FE. Publikationsudbyttet af Hjerteforeningens forskningsbevillinger 1988-1990 [Publication outcome of research funding by the Danish Heart Foundation 1988-1990]. Ugeskr Laeger. 1998;160(32):4644-8. Danish. [PubMed]
31. Ahmad P, Vincent Abbott P, Khursheed Alam M, Ahmed Asif J. A bibliometric analysis of the top 50 most cited articles published in the Dental Traumatology. Dent Traumatol. 2020;36(2):89-99. [Crossref] [PubMed]
32. Ahmad P, Dummer PMH, Noorani TY, Asif JA. The top 50 most-cited articles published in the International Endodontic Journal. Int Endod J. 2019;52(6):803-18. [Crossref] [PubMed]
33. Ullah R, Adnan S, Afzal AS. Top-Cited Articles from Dental Education Journals, 2009 to 2018: A Bibliometric Analysis. J Dent Educ. 2019;83(12):1382-91. [Crossref] [PubMed]
34. Ordinola-Zapata R, Peters OA, Nagendrababu V, Azevedo B, Dummer PMH, Neelakantan P. What is of interest in Endodontology? A bibliometric review of research published in the International Endodontic Journal and the Journal of Endodontics from 1980 to 2019. Int Endod J. 2020;53(1):36-52. [Crossref] [PubMed]
35. Ismail AI, Bader JD; ADA Council on Scientific Affairs and Division of Science; Journal of the American Dental Association. Evidence-based dentistry in clinical practice. J Am Dent Assoc. 2004;135(1):78-83. [Crossref] [PubMed]