Original Article

The 100 top-cited articles in orthodontics from 1975 to 2011

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ABSTRACT

Objective: To identify the 100 top-cited articles published in orthodontics journals and to analyze their characteristics to investigate the achievement and development of orthodontics research in past decades.

Methods and Materials: The Institute for Scientific Information Web of Knowledge Database and the 2011 Journal Citation Report Science Editions were used to retrieve the 100 top-cited articles published in orthodontics journals since 1975. Some basic information was collected by the Analyze Tool on the Web of Science, including citation time, publication title, journal name, publication year, and country and institution of origin. A further study was then performed to determine authorship, article type, field of study, study design, and level of evidence.

Results: The 100 target articles were retrieved from three journals: *American Journal of Orthodontics and Dentofacial Orthopedics* (n = 74), *The Angle Orthodontist* (n=15), and *European Journal of Orthodontics* (n = 11). Since 1975, the articles cited 89 to 545 times mainly originated from the United States, and the overwhelming majority of articles were clinical. The most common study design was case series; 40 articles were classified as level IV and 12 as level V evidence.

Conclusions: The 100 top-cited articles in orthodontics are generally old articles, rarely possessing high-level evidence. (*Angle Orthod.* 2013;83:491–499.)

KEY WORDS: Bibliometrics; Citation analysis; Top-cited; Orthodontics

INTRODUCTION

Bibliometrics enables researchers to explore the impact of a specific field. In a certain sense, it is a citation index that is now widely accepted as a measurement of recognition, although it is not a measurement of quality or importance.[1]

Journal Citation Reports (JCR) provides a systematic and objective means of evaluating the leading global journals critically, with quantifiable, statistical information based on citation data.[2] The Web of Science, an intelligent research platform, has access to the world's leading citation databases, making cited reference searching possible.[3]

Recently, numerous citation analyses and top-cited articles have become available in various specialties, such as dermatology,[4] general surgery,[5] anesthetics,[6] plastic surgery,[7] urology,[8] neurosurgery,[9] rehabilitation,[10] ophthalmology,[11] orthopedic surgery,[12] and endodontics.[13] In the past 4 years, more analogous articles have been found in the Science Citation Index. In total, two top-cited articles were published in dentistry. The one in the field of periodontology was published in *Journal of Clinical Periodontology*[14] in 2007, and the other was published in *Journal of Endodontics*[13] in 2011.

Today, an increasing number of studies on bibliometrics or citation analysis in orthodontics are being conducted.[15–19] However, no analogous study in the field of orthodontics has appeared domestically and overseas. The purpose of the present study was to identify the 100 top-cited articles published in professional orthodontics journals and analyze their characteristics. The expectation was to provide some references for future studies and clinical practices by categorizing types of studies and grading evidence levels of the articles.

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MATERIALS AND METHODS

In early November 2011, we identified the 100 top-cited articles (Table 1) published in professional orthodontics journals since 1975 by the Web of Science. In the 2011 Science Citation Index, 79 journals were listed under the subject category ''Dentistry, Oral Surgery & Medicine,'' and six professional journals in orthodontics were found. However, three of the professional orthodontics journals were excluded because they did not contribute to the list of top-cited articles. The impact factors of the remaining three professional orthodontics journals were collected from the 2011 JCR. Then, all articles in each given journal were ranked by the number of citations listed on the Web of Science. The 100 top-cited articles were identified among 13,135 articles published in the three major specialized orthodontics journals. The full texts were mainly selected by PubMed, the online *Angle Orthodontist*, and ScienceDirect. In addition, other methods were used to search for the articles were not found in the aforementioned databases, for example, interlibrary lending and requests for help on the PubMed.cn website (http://paper.pubmed.cn/).

After they were retrieved from the three orthodontics journals, the 100 top-cited articles were incorporated into an Excel spreadsheet. From the Web of Science, basic information concerning country of origin (based on the first author), institution, year of publication, publication name, and citations of the target articles was collected using the analyze tool. Then, a further study on authorship, article type, field of study, study design, and level of evidence was performed.

According to the method of Anastasia Fardi,[13] the types of articles were classified as basic science, clinical research, and review. A clinical study, in contrast to a theoretical or basic science article, is one that pertains to or founded on the observation and treatment of participants.[20] It is generally designed to prevent, treat or cure disease by means of drugs, devices or interventions. It includes systematic review, meta-analysis, randomized controlled trial (RCT), cohort study, case-control study, cross-sectional study, case series, case report, and expert opinion. A basic science article is one dedicated to basic science/biomechanics, basic science/animal research, or basic science/in vitro study. In order to describe the fields of the studies, two of us read the full text on the list and summarized respectively. Then the summary sheet was completed by discussion. Level of evidence was evaluated by the Sackett initial and updated rules of evidence, as described by the Oxford Centre for Evidence-Based Medicine in 2009.[21] To determine the level of evidence for an article, the first step was to define its study design following the design tree.[22] The study whose type can be worked by the study designs above is clinical. The next step was to ascertain the classification of these clinical studies (therapy/prevention, etiology/harm; prognosis; diagnosis; differential diagnosis/symptom prevalence; economic and decision analyses). Next, the level of evidence (level I to V) of clinical articles was graded. The material (article type, field of study, study design, and level of evidence) was collected and classified by two investigators. The data were discussed until a consensus was reached.

RESULTS

Journals and Publication Dates of the Top-Cited articles in Orthodontics

The 100 top-cited articles were published in three journals: 74 were from the *American Journal of Orthodontics and Dentofacial Orthopedics*, 15 were from *The Angle Orthodontist*, and 11 were from the *European Journal of Orthodontics.* Journal title, impact factor, number of citations, and number of articles are listed in Table 2A.

The 100 top-cited articles in orthodontics were published from 1975 to 2006. The greatest number of top-cited articles (n = 8) were published in 1976, and seven top-cited articles were published in 1981, 1987, and 1998 each (Table 2B). Articles on the list were divided into three periods, 1975 to 1984 (n = 47), 1985 to 1994 (n = 40), and after 1995 (n = 13). Ninety-three percent of the articles were published before 2000, and only one target article was published after 2005.

Authors of the Top-Cited Articles in Orthodontics

Authors contributing two or more articles to the list are listed in Table 3. The number of authors of the top-cited articles ranged from 1 to 10, and the most common figures were 1 to 3. According to data statistics, 29 articles had one author, followed by 24 articles with two authors, and 23 articles with three authors. The most frequent first authors of the top-cited articles in orthodontics were J. A. McNamara Jr (n = 4) and R. M. Little (n = 4), both of whom accounted for five articles on the list. Furthermore, W. E. Roberts, H. Pancherz, and A. A. Lowe were each listed as the first author for three articles.

Countries and Institutions of Origin

According to their countries of origin (based on the first author), more than half of the articles were generated in the United States (n = 53), which led the list (Table 4A). Sweden (n = 10) was the second most productive country, followed by Japan (n = 8) and Norway (n = 7). Canada and Denmark each contributed five articles to the list, and England provided four articles. The 23 leading institutions that provided two or more top-cited articles in orthodontics are listed in Table 4B. The University of Michigan in

Table 1. The 100 Top-Cited Articles in Orthodontics

Rank	Article	No. of Citations
1	Houston WJ. The analysis of errors in orthodontic measurements. *Am J Orthod*. 1983;83:382–390.	545
2	Björk A, Skieller V. Normal and abnormal growth of the mandible. A synthesis of longitudinal cephalometric implant studies over a period of 25 years. *Eur J Orthod*. 1983;5:1–46.	298
3	Artun J, Bergland S. Clinical trials with crystal growth conditioning as an alternative to acid-etch enamel pretreatment. *Am J Orthod*. 1984;85:333–340.	298
4	Gorelick L, Geiger AM, Gwinnett AJ. Incidence of white spot formation after bonding and banding. *Am J Orthod*. 1982;81:93–98.	271
5	Brook PH, Shaw WC. The development of an index of orthodontic treatment priority. *Eur J Orthod*. 1989;11:309–320.	241
6	Roberts WE, Smith RK, Zilberman Y, Mozsary PG, Smith RS. Osseous adaptation to continuous loading of rigid endosseous implants. *Am J Orthod*. 1984;86:95–111.	230
7	Mcnamara JA. A method of cephalometric evaluation. *Am J Orthod Dentofacial Orthop*. 1984;86:449–469	213
8	Little RM. The irregularity index: a quantitative score of mandibular anterior alignment. *Am J Orthod*. 1975;68:554–563.	193
9	Miyawaki S, Koyama I, Inoue M, Mishima K, Sugahara T, Takano-Yamamoto T. Factors associated with the stability of titanium screws placed in the posterior region for orthodontic anchorage. *Am J Orthod Dentofacial Orthop*. 2003;124:373–378.	193
10	Little RM, Wallen TR, Riedel RA. Stability and relapse of mandibular anterior alignment-first premolar extraction cases treated by traditional edgewise orthodontics. *Am J Orthod*. 1981;80:349–365.	189
11	Jacobson A. The "Wits" appraisal of jaw disharmony. *Am J Orthod*. 1975;67:125–138.	187
12	O'Reilly MM, Featherstone JD. Demineralization and remineralization around orthodontic appliances: an in vivo study. *Am J Orthod Dentofacial Orthop*. 1987;92:33–40.	182
13	Umemori M, Sugawara J, Mitani H, Nagasaka H, Kawamura H. Skeletal anchorage system for open-bite correction. *Am J Orthod Dentofacial Orthop*. 1999;115:166–174.	182
14	Moyers RE, Bookstein FL. The inappropriateness of conventional cephalometrics. *Am J Orthod*. 1979;75:599–617.	174
15	Roberts WE, Helm FR, Marshall KJ, Gongloff RK. Rigid endosseous implants for orthodontic and orthopedic anchorage. *Angle Orthod*. 1989;59:247–256.	173
16	Pancherz H. The mechanism of Class II correction in Herbst appliance treatment. A cephalometric investigation. *Am J Orthod*. 1982;82:104–113.	172
17	Schendel SA, Eisenfeld J, Bell WH, Epker BN, Mishelevich DJ. The long face syndrome: vertical maxillary excess. *Am J Orthod*. 1976;70:398–408.	167
18	McNamara JA Jr, Carlson DS. Quantitative analysis of temporomandibular joint adaptations to protrusive function. *Am J Orthod*. 1979;76:593–611.	165
19	Miura F, Mogi M, Ohura Y, Hamanaka H. The super-elastic property of the Japanese NiTi alloy wire for use in orthodontics. *Am J Orthod Dentofacial Orthop*. 1986;90:1–10.	158
20	Holdaway RA. A soft-tissue cephalometric analysis and its use in orthodontic treatment planning. Part I. *Am J Orthod*. 1983;84:1–28.	157
21	Ogaard B, Rølla G, Arends J. Orthodontic appliances and enamel demineralization. Part 1. Lesion development. *Am J Orthod Dentofacial Orthop*. 1988;94:68–73.	157
22	Ricketts RM. Perspectives in the clinical application of cephalometrics. The first fifty years. *Angle Orthod*. 1981;51:115–150.	155
23	Proffit WR. Equilibrium theory revisited: factors influencing position of the teeth. *Angle Orthod*. 1978;48:175–186.	152
24	Tasaki MM, Westesson PL, Isberg AM, Ren YF, Tallents RH. Classification and prevalence of temporomandibular joint disk displacement in patients and symptom-free volunteers. *Am J Orthod Dentofacial Orthop*. 1996;109:249–262.	146
25	Little RM, Riedel RA, Artun J. An evaluation of changes in mandibular anterior alignment from 10 to 20 years postretention. *Am J Orthod Dentofacial Orthop*. 1988;93:423–428.	144
26	Lowe AA, Santamaria JD, Fleetham JA, Price C. Facial morphology and obstructive sleep apnea. *Am J Orthod Dentofacial Orthop*. 1986;90:484–491.	143
27	Sinclair PM, Little RM. Maturation of untreated normal occlusions. *Am J Orthod*. 1983;83:114–123.	136
28	Haas AJ. Long-term posttreatment evaluation of rapid palatal expansion. *Angle Orthod*. 1980;50:189–217.	133
29	Harvold EP, Tomer BS, Vargervik K, Chierici G. Primate experiments on oral respiration. *Am J Orthod*. 1981;79:359–372.	132
30	Zachrisson BJ. A posttreatment evaluation of direct bonding in orthodontics. *Am J Orthod*. 1977;71:173–189.	130
31	Pancherz H. Treatment of class II malocclusions by jumping the bite with the Herbst appliance. A cephalometric investigation. *Am J Orthod*. 1979;76:423–442.	127
32	McNamara JA Jr. Components of class II malocclusion in children 8–10 years of age. *Angle Orthod*. 1981;51:177–202.	127
33	Shaw WC. The influence of children's dentofacial appearance on their social attractiveness as judged by peers and lay adults. *Am J Orthod*. 1981;79:399–415.	127
34	Guyer EC, Ellis EE, McNamara JA Jr, Behrents RG. Components of class III malocclusion in juveniles and adolescents. *Angle Orthod*. 1986;56:7–30.	127
35	McNamara JA Jr, Bookstein FL, Shaughnessy TG. Skeletal and dental changes following functional regulator therapy on class II patients. *Am J Orthod*. 1985;88:91–110.	125
36	Zachrisson BU. Cause and prevention of injuries to teeth and supporting structures during orthodontic treatment. *Am J Orthod*. 1976;69:285–300.	123
37	Solow B, Siersbaek-Nielsen S, Greve E. Airway adequacy, head posture, and craniofacial morphology. *Am J Orthod*. 1984;86:214–223.	123
38	Ranta R. A review of tooth formation in children with cleft lip/palate. *Am J Orthod Dentofacial Orthop*. 1986;90:11–18.	123

Table 1. Continued.

Rank	Article	No. of Citations
39	Roberts WE, Marshall KJ, Mozsary PG. Rigid endosseous implant utilized as anchorage to protract molars and close an atrophic extraction site. *Angle Orthod*. 1990;60:135–152.	123
40	Linge BO, Linge L. Apical root resorption in upper anterior teeth. *Eur J Orthod*. 1983;5:173–183.	121
41	Ogaard B. Prevalence of white spot lesions in 19-year-olds: a study on untreated and orthodontically treated persons 5 years after treatment. *Am J Orthod Dentofacial Orthop*.1989;96:423–427.	117
42	Riolo ML, Brandt D, TenHave TR. Associations between occlusal characteristics and signs and symptoms of TMJ dysfunction in children and young adults. *Am J Orthod Dentofacial Orthop*. 1987;92:467–477.	115
43	Bednar JR, Gruendeman GW, Sandrik JL. A comparative study of frictional forces between orthodontic brackets and arch wires. *Am J Orthod Dentofacial Orthop*. 1991;100:513–522.	114
44	Bishara SE, Staley RN. Maxillary expansion: clinical implications. *Am J Orthod Dentofacial Orthop*.1987;91:3–14.	108
45	Tulloch JF, Phillips C, Proffit WR. Benefit of early Class II treatment: progress report of a two-phase randomized clinical trial. *Am J Orthod Dentofacial Orthop*. 1998;113:62–72.	106
46	Burstone CR. Deep overbite correction by intrusion. *Am J Orthod*. 1977;72:1–22.	105
47	Shaw WC, Rees G, Dawe M, Charles CR. The influence of dentofacial appearance on the social attractiveness of young adults. *Am J Orthod*. 1985;87:21–26.	105
48	Paquette DE, Beattie JR, Johnston LE Jr. A long-term comparison of nonextraction and premolar extraction edgewise therapy in ''borderline'' Class II patients. *Am J Orthod Dentofacial Orthop*. 1992;102:1–14.	105
49	Peck S, Peck L, Kataja M. The palatally displaced canine as a dental anomaly of genetic origin. *Angle Orthod*. 1994;64:249–256.	105
50	Frost HM. Wolff's law and bone's structural adaptations to mechanical usage: an overview for clinicians. *Angle Orthod*. 1994;64:175–188.	104
51	Pancherz H. The Herbst appliance—its biologic effects and clinical use. *Am J Orthod*. 1985;87:1–20.	103
52	Bishara SE, VonWald L, Laffoon JF, Warren JJ. Effect of a self-etch primer/adhesive on the shear bond strength of orthodontic brackets. *Am J Orthod Dentofacial Orthop*. 2001;119:621–624.	103
53	Kiliaridis S, Engström C, Thilander B. The relationship between masticatory function and craniofacial morphology. I. A cephalometric longitudinal analysis in the growing rat fed a soft diet. *Eur J Orthod*. 1985;7:273–283.	102
54	Linge L, Linge BO. Patient characteristics and treatment variables associated with apical root resorption during orthodontic treatment. *Am J Orthod Dentofacial Orthop*. 1991;99:35–43.	102
55	Saito M, Saito S, Ngan PW, Shanfeld J, Davidovitch Z. Interleukin 1 beta and prostaglandin E are involved in the response of periodontal cells to mechanical stress in vivo and in vitro. *Am J Orthod Dentofacial Orthop*. 1991;99:226–240.	102
56	Lowe AA, Gionhaku N, Takeuchi K, Fleetham JA. Three-dimensional CT reconstructions of tongue and airway in adult subjects with obstructive sleep apnea. *Am J Orthod Dentofacial Orthop*. 1986;90:364–374.	101
57	Tencate AR, Deporter DA, Freeman E. The role of fibroblasts in the remodeling of periodontal ligament during physiologic tooth movement. *Am J Orthod*. 1976;69:155–168.	100
58	Egermark-Eriksson I, Carlsson GE, Ingervall B. Prevalence of mandibular dysfunction and orofacial parafunction in 7-, 11- and 15-year-old Swedish children. *Eur J Orthod*. 1981;3:163–172.	100
59	Ericson S, Kurol J. Radiographic examination of ectopically erupting maxillary canines. *Am J Orthod Dentofacial Orthop*. 1987;91:483–492.	100
60	Ericson S, Kurol J. Early treatment of palatally erupting maxillary canines by extraction of the primary canines. *Eur J Orthod*. 1988;10:283–295.	100
61	Park HS, Jeong SH, Kwon OW. Factors affecting the clinical success of screw implants used as orthodontic anchorage. *Am J Orthod Dentofacial Orthop*. 2006;130:18–25.	100
62	Vig PS, Hewitt AB. Asymmetry of the human facial skeleton. *Angle Orthod*. 1975;45:125–129.	99
63	Boyne PJ, Sands NR. Combined orthodontic-surgical management of residual palato-alveolar cleft defects. *Am J Orthod*. 1976;70:20–37.	99
64	Throckmorton GS, Finn RA, Bell WH. Biomechanics of differences in lower facial height. *Am J Orthod*. 1980;77: 410–420.	99
65	Woodside DG, Metaxas A, Altuna G. The influence of functional appliance therapy on glenoid fossa remodeling. *Am J Orthod Dentofacial Orthop*. 1987;92:181–198.	99
66	Andreasen JO, Paulsen HU, Yu Z, Schwartz O. A long-term study of 370 autotransplanted premolars. Part III. Periodontal healing subsequent to transplantation. *Eur J Orthod*. 1990;12:25–37.	99
67	Schendel SA, Eisenfeld JH, Bell WH, Epker BN. Superior repositioning of the maxilla: stability and soft tissue osseous relations. *Am J Orthod*. 1976;70:663–674.	98
68	Graber LW. Chin cup therapy for mandibular prognathism. *Am J Orthod*. 1977;72:23–41.	98
69	Burstone CJ, Bai Q, Morton JY. Chinese NiTi wire—a new orthodontic alloy. *Am J Orthod*. 1985;87:445–452.	98
70	Newman WG. Possible etiologic factors in external root resorption. *Am J Orthod*. 1975;67:522–539.	97
71	Bell RA. A review of maxillary expansion in relation to rate of expansion and patient's age. *Am J Orthod*. 1982;81:32–37.	97
72	Artun J, Brobakken BO. Prevalence of carious white spots after orthodontic treatment with multibonded appliances. *Eur J Orthod*. 1986;8:229–234.	97
73	Glenn G, Sinclair PM, Alexander RG. Nonextraction orthodontic therapy: posttreatment dental and skeletal stability. *Am J Orthod Dentofacial Orthop*. 1987;92:321–328.	97
74	Levander E, Malmgren O. Evaluation of the risk of root resorption during orthodontic treatment: a study of upper incisors. *Eur J Orthod*. 1988;10:30–38.	97

Table 1. Continued.

Rank	Article	No. of Citations
75	Liou EJ, Pai BC, Lin JC. Do miniscrews remain stationary under orthodontic forces? *Am J Orthod Dentofacial Orthop*. 2004;126:42–47.	97
76	Irie M, Nakamura S. Orthopedic approach to severe skeletal Class III malocclusion. *Am J Orthod*. 1975;67:377–392.	96
77	Hotz M, Gnoinski W. Comprehensive care of cleft lip and palate children at Zürich university: a preliminary report. *Am J Orthod*. 1976;70:481–504.	96
78	Burstone CJ, Pryputniewicz RJ. Holographic determination of centers of rotation produced by orthodontic forces. *Am J Orthod*. 1980;77:396–409.	96
79	Beecher RM, Corruccini RS. Effects of dietary consistency on craniofacial and occlusal development in the rat. *Angle Orthod*. 1981;51:61–69.	96
80	Keeling SD, Wheeler TT, King GJ, Garvan CW, Cohen DA, Cabassa S, McGorray SP, Taylor MG. Anteroposterior skeletal and dental changes after early Class II treatment with bionators and headgear. *Am J Orthod Dentofacial Orthop*. 1998;113:40–50.	96
81	Hershey HG, Stewart BL, Warren DW. Changes in nasal airway resistance associated with rapid maxillary expansion. *Am J Orthod*. 1976;69:274–284.	95
82	Block MS, Hoffman DR. A new device for absolute anchorage for orthodontics. *Am J Orthod Dentofacial Orthop*. 1995;107:251–258.	95
83	Tanne K, Sakuda M, Burstone CJ. Three-dimensional finite element analysis for stress in the periodontal tissue by orthodontic forces. *Am J Orthod Dentofacial Orthop*. 1987;92:499–505.	94
84	Oliver RG. The effect of different methods of bracket removal on the amount of residual adhesive. *Am J Orthod Dentofacial Orthop*. 1988;93:196–200.	94
85	Turley PK, Kean C, Schur J, Stefanac J, Gray J, Hennes J, Poon LC. Orthodontic force application to titanium endosseous implants. *Angle Orthod*. 1988;58:151–162.	94
86	Bell WH, Epker BN. Surgical-orthodontic expansion of the maxilla. *Am J Orthod*. 1976;70:517–528.	93
87	Bonham PE, Currier GF, Orr WC, Othman J, Nanda RS. The effect of a modified functional appliance on obstructive sleep apnea. *Am J Orthod Dentofacial Orthop*. 1988;94:384–392.	93
88	Vastardis H. The genetics of human tooth agenesis: new discoveries for understanding dental anomalies. *Am J Orthod Dentofacial Orthop*. 2000;117:650–656.	93
89	Frost HM. A 2003 update of bone physiology and Wolff's law for clinicians. *Angle Orthod*. 2004;74:3–15.	93
90	Sadowsky C, Polson AM. Temporomandibular disorders and functional occlusion after orthodontic treatment: results of two long-term studies. *Am J Orthod*. 1984;86:386–390.	92
91	Wertz R, Dreskin M. Midpalatal suture opening: a normative study. *Am J Orthod*. 1977;71:367–381.	91
92	Andreasen JO, Paulsen HU, Yu Z, Bayer T, Schwartz O. A long-term study of 370 autotransplanted premolars. Part II. Tooth survival and pulp healing subsequent to transplantation. *Eur J Orthod*. 1990;12:14–24.	91
93	Lowe AA, Fleetham JA, Adachi S, Ryan CF. Cephalometric and computed tomographic predictors of obstructive sleep apnea severity. *Am J Orthod Dentofacial Orthop*. 1995;107:589–595.	91
94	Melsen B. Palatal growth studied on human autopsy material. A histologic microradiographic study. *Am J Orthod*. 1975;68:42–54.	90
95	Rygh P. Orthodontic root resorption studied by electron microscopy. *Angle Orthod*. 1977;47:1–16.	90
96	Hägg U, Matsson L. Dental maturity as an indicator of chronological age: the accuracy and precision of three methods. *Eur J Orthod*. 1985;7:25–34.	90
97	Little RM, Riedel RA, Stein A. Mandibular arch length increase during the mixed dentition: postretention evaluation of stability and relapse. *Am J Orthod Dentofacial Orthop*. 1990;97:393–404.	89
98	Nanda RS, Meng H, Kapila S, Goorhuis J. Growth changes in the soft tissue facial profile. *Angle Orthod*. 1990;60:177–190.	89
99	Paesani D, Westesson PL, Hatala M, Tallents RH, Kurita K. Prevalence of temporomandibular joint internal derangement in patients with craniomandibular disorders. *Am J Orthod Dentofacial Orthop*. 1992;101:41–47.	89
100	Ohmae M, Saito S, Morohashi T, Seki K, Qu H, Kanomi R, Yamasaki KI, Okano T, Yamada S, Shibasaki Y. A clinical and histological evaluation of titanium mini-implants as anchors for orthodontic intrusion in the beagle dog. *Am J Orthod Dentofacial Orthop*. 2001;119:489–497.	89

the United States produced the largest number of orthodontics articles (n = 8), followed by the University of Washington (n = 7), the University of Oslo (n = 6), and the University of Texas (n = 5).

Type of Articles and Field of Study

Among the 100 top-cited articles in orthodontics, the overwhelming majority (n = 63) reported clinical experience; 30 articles concerned basic science research and 7 were review articles (Table 5). In the 100 top-cited orthodontics articles, the term ''implant'' appeared most frequently. Next in the ranking were studies in ''biomechanics and biology'' and ''airway resistance,'' followed by ''orthodontic appliance, functional, Class II correction'' and ''temporomandibular joint/temporomandibular disorders.''

Design of Study and Level of Evidence of the Top-Cited Articles in Orthodontics

The study design of 63 clinical articles among the 100 top-cited orthodontics articles is shown in Table 6. A large number of articles had a case series design

Table 2A. Journals in Which the 100 Top-Cited Articles in Orthodontics Were Originally Published

Rank	Journal	Impact Factor		No. of Articles	Median No. of Citations (Range)
		2010	Median (2006–2010)		
1	*American Journal of Orthodontics and Dentofacial Orthopedics*	1.35	1.287	74	131.74 (89–545)
2	*The Angle Orthodontist*	1.00	0.969	15	117.33 (89–173)
3	*European Journal of Orthodontics*	0.93	0.932	11	130.55 (90–298)

(n = 22), and the next most common design was cross-sectional study (n = 14). In addition, eight articles were cohort studies, and only three articles described RCTs.

According to the study designs, the levels of evidence of 63 clinical articles are presented in Table 7. Most articles were classified as level IV (n = 40) or level V (n = 12) evidence.

DISCUSSION

The period from the 1940s through the 1970s, witnessed significant achievements, developments, and scientific progress in the orthodontics field. The present study, however, only included articles from the Web of Knowledge Database that dated after 1975. So an interesting future study in top-cited orthodontics articles might include articles dating back to 1945, which has already been done for general surgery[5] and anesthetics[6] articles.

Initially, six journals in orthodontics were selected in the 2011 Science Citation Index, three of which, the *Australian Orthodontics Journal*, the *Korean Journal of Orthodontics*, and the *Journal of Orofacial Orthodontics Fortschritte der Kieferorthopadie* were finally excluded because there is not a top-cited article published in any of them. The three excluded journals contained 104, 191, and 141 articles, respectively, from 1975 to 2011. The maximum citations of the articles published in them merely reached 7, 20, and 11. The target articles were retrieved from three journals: *American Journal of Orthodontics and Dentofacial Orthopedics* (n = 74), *The Angle Orthodontist* (n = 15), and the *European Journal of Orthodontics*

Table 2B. Year in Which the 100 Top-Cited Articles in Orthodontics Were Published

Rank	Year of Publication	No. of Articles
1	1976	8
2	1981	7
3	1987	7
4	1988	7
5	1975	6
6	1985	6
7	1986	6
8	1977	5
9	1983	5
10	1984	5
11	1990	5
12	1980	4
13	1979	3
14	1982	3
15	1989	3
16	1991	2
17	1992	2
18	1994	2
19	1995	2
20	1998	2
21	2001	2
22	2004	2
23	1978	1
24	1996	1
25	1999	1
26	2000	1
27	2003	1
28	2006	1

Table 3. Authors with Two or More Top-Cited Articles in Orthodontics

Rank	Author	No. of Citation Classics	No. of Articles	
			As First Author	As Coauthor
1	McNamara JA Jr	5	4	1
2	Little RM	5	4	1
3	Bell WH	4	1	3
4	Roberts WE	3	3	0
5	Pancherz H	3	3	0
6	Lowe AA	3	3	0
7	Shaw WC	3	2	1
8	Artun J	3	2	1
9	Riedel RA	3	0	3
10	Fleetham JA	3	0	3
11	Epker BN	3	0	3
12	Schendel SA	2	2	0
13	Ogaard B	2	2	0
14	Marshall KJ	2	2	0
15	Frost HM	2	2	0
16	Ericson S	2	2	0
17	Burstone CJ	2	2	0
18	Bishara SE	2	2	0
19	Andreasen JO	2	2	0
20	Sinclair PM	2	1	1
21	Nanda RS	2	1	1
22	Linge L	2	1	1
23	Westesson PL	2	0	2
24	Tallents RH	2	0	2
25	Schwartz O	2	0	2
26	Saito S	2	0	2
27	Paulsen HU	2	0	2
28	Kurol J	2	0	2
29	Bookstein FL	2	0	2
30	Yu Z	2	0	2

Table 4A. Country of Origin of the 100 Top-Cited Articles in Orthodontics

Rank	Country of Origin	No. of Articles
1	United States	53
2	Sweden	10
3	Japan	8
4	Norway	7
5	Canada	5
6	Denmark	5
7	England	4
8	Finland	2
9	Wales	2

(n = 11). In 2010, Shimada[23] reported that RCT trials on orthodontics practice in PubMed were published in four orthodontic journals, and the leading journals were *American Journal of Orthodontics and Dentofacial Orthopedics* and *The Angle Orthodontist*. Although measures were taken to search the full texts of articles on the list, two were not available. One was published in the *American Journal of Orthodontics and Dentofacial Orthopedics* in 1981, and the other in the *European Journal of Orthodontics* in 1983. Callaham et al.[24] found that the impact factor of the original publishing journal was the widely effective predictor of citations each year, rather than the methodology or quality of the research. However, as shown in this present study (Table 2), the actual citation of the individual article did not positively related to the impact factor of the journal.

Generally, as shown in the results, the 100 top-cited articles in orthodontics were older articles, and only one target article was published after 2005. It has been reported that scientific articles begin to be cited 1 or 2 years after publication, and reach a maximum citation rate 7 to 10 years later after publication.[25] An interval of 10 years to 20 years is needed for maximal recognition of prominent articles in a field.[26–28] This may explain why recent articles were cited rarely and appeared scarcely on the list.

Table 4B. Institution of Origin with Two or More Top-Cited Articles in Orthodontics

Rank	Institution	No. of Articles
1	University of Michigan	8
2	University of Washington	7
3	University of Oslo	6
4	University of Texas	5
5	Eastman Dental Center	4
6	University of Connecticut	4
7	University of North Carolina	4
8	University of Pacific School of Dentistry	4
9	University of British Columbia	3
10	Indiana University	2
11	Institute for Postgraduate Dental Education	2
12	John Peter Smith Hospital	2
13	Parkland Memorial Hospital	2
14	The Royal College of Dental Surgeons of Ontario	2
15	Showa University	2
16	Southern Colorado Clinic	2
17	Saint Louis University	2
18	University of Copenhagen Hospital	2
19	University of Iowa	2
20	University of Lund	2
21	University of Oklahoma	2
22	University of Rochester	2
23	University of Toronto	2

Table 5. Field of Study of the Different Types of Studies

Field of Study	Total	Clinical	Basic	Review
Implants	10	5	5	0
Airway resistance	7	6	1	0
Biomechanics and biology	7	0	4	3
Orthodontic appliance, functional, Class II correction	6	5	1	0
Temporomandibular joint/temporomandibular disorders	6	5	1	0
Demineralization	5	4	1	0
Root resorption	5	4	1	0
Palatal expansion	5	3	0	2
Bracket bonding and removal	4	2	2	0
Cephalometry	4	2	1	1
Growth and development	4	0	4	0
Assessing index	3	3	0	0
Stability and relapse of mandibular treatment	3	3	0	0
Ectopically erupting maxillary canine	3	2	1	0
Vertical disorder	3	2	1	0
Cleft lip and/or palate	3	2	0	1
Auto-dental transplantation	2	2	0	0
Components of malocclusion class	2	2	0	0
Extraction and nonextraction orthodontic therapy	2	2	0	0
Social attractiveness	2	2	0	0
Soft-tissue facial profile	2	1	1	0
Mastication and malocclusion	2	0	2	0
Wire	2	0	2	0
Deep overbite correction	1	1	0	0
Injuries during orthodontic treatment	1	1	0	0
Orthodontic appliance, chin cup	1	1	0	0
Skeletal asymmetry	1	1	0	0
Skeletal Class III malocclusion	1	1	0	0
Two-phase treatment	1	1	0	0
Friction	1	0	1	0
Human molecular genetics approach to familial tooth agenesis	1	0	1	0

Table 6. Study Design of the Clinical Studies

Study Design	No. of Articles
Experimental study	
Randomized, controlled trial	3
Observational study	
Cohort study	8
Case-control study	4
Descriptive study	
Cross-sectional study	14
Case series	22
Case report	6
Expert opinion	6

Table 7. Level of Evidence of the Clinical Studies

Level of Evidence	Therapy/Prevention, Etiology/Harm	Prognosis	Diagnosis	Differential Diagnosis/Symptom Prevalence	Economic and Decision Analysis
I					
a	0	0	0	0	0
b	0	0	0	0	0
c	0	0	0	0	0
II					
a	0	0	0	0	0
b	11	0	0	0	0
c	0	0	0	0	0
III					
a	0	0	0	0	0
b	0	0	0	0	0
IV	27	0	7	6	0
V	8	0	4	0	0

Among the 100 top-cited articles in orthodontics, the most common design was case series (n = 22), followed by cross-sectional study (n = 14) (Table 6), indicating that descriptive studies occur most frequently in orthodontics. This might indicated the relative ease of performing simpler study designs in orthodontics. A 2011 study by Pandis et al.[29] on articles published in six major clinical dental specialized journals indicated that the dominant design was cross-sectional study. It is recognized that different study design could correspond to different levels of evidence. In the hierarchy of research study designs, systematic reviews, meta-analyses, and RCTs provide the highest quality of evidence, and the lowest grade is applied to case reports and expert opinions. The goal of rating study designs and levels of evidence is to indicate the best available evidence for use in patient care. Actually, the conclusions of descriptive studies can be effectively applied to patient care, although they represent a lower level of evidence (level IV or level V). There was a paucity of articles with high-level evidence in orthodontics. The target articles mainly focused on therapy, and there were no economic studies. However, economic studies are of considerable value because they play a significant role in clinical decision-making.

Among the target articles, there were only 3 RCTs, although RCTs are considered to provide the highest-quality evidence for most clinical or interventional questions. Moreover, few RCTs were found among the top medical articles; for example, there were 14 RCTs in urology[8], 9 in rehabilitation[10], and 0 in orthopedics[12] and endodontology[13]. There are several possible explanations for the lack of RCTs in orthodontics. First, RCTs are expensive and time consuming to perform. Second, it is difficult to gather large sample and control groups.[30] Third, it may be that few years had passed since the publication of the RCTs, so they had not yet reached a significant number of citations. Therefore, it is important for more journals to assess the evidence levels of articles and choose those that provide good evidence, which are most helpful to readers. Furthermore, future studies with a higher level of evidence, if appropriate, may deserve to pursue.

Although we spared no effort to eliminate potential defects in this citation analysis, some limitations related to its inherent problems were inevitable. First and foremost, this survey was restricted to journals with the word "orthodontics" or "orthodontist" in their titles. In other words, some significant orthodontics articles published in other dentistry journals were excluded, and it is possible that these were good- quality articles with a high number of citations. For example, an article about the use of palatal implants for orthodontic anchorage design and clinical application of the orthosystem published by Wehrbein et al. in *Clinical Oral Implant Research*[31] was cited more times (103) than the minimum number of citations (89) in our the list. In addition, a 2003 article on the use of small titanium screws for orthodontic anchorage, published in the *Journal of Dental Research*,[32] was cited 101 times. Second, in the present study, we searched the material only via the Internet, ignoring articles published only in print from the limited material in our library. Without accessing resources available both in print and online, some information will potentially be lost.[33] In addition, a number of high-quality articles were published before 1975. Third, time can have a number of effects on the citation ranking of articles. Consequently, the dominant articles in the list could be old studies, whereas some high-quality, innovative, and meaningful articles published in the recent years would be undervalued. In fact, the older articles with a high number of citations are of value in their field. Some of the top-cited articles, for example, may be submitted to organizational reading lists. And most persons in study clubs and journal clubs and students of all ages have been reading the older classical articles year after year. However,

there are some good-quality articles among the recent publications, and they deserve more attention. Therefore, it is necessary to evaluate the quality of the new articles, for example, assessing an article by grading its level of evidence. Fourth, lack of correction for self-citations by a journal or an author was a great challenge for the citation analysis.

Despite these obvious defects, the data presented here provide insight into the achievement and development of orthodontics research over the past decades.

CONCLUSIONS

- To the best of our knowledge, this is the first study of the 100 top-cited articles in the field of orthodontics.
- The 100 top-cited articles in orthodontics are generally older articles; 95% were published more than 10 years ago.
- The common study design of the top-cited orthodontics articles is descriptive study.
- Articles using high-level evidence rarely appear in the 100 top-cited articles in orthodontics.

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