100 Most Cited Articles in Orthopaedic Surgery

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Abstract

Background Citation analysis reflects the recognition a work has received in the scientific community by its peers, and is a common method to determine ‘classic’ works in medical specialties.

Questions/purposes We determined which published articles in orthopaedic journals have been most cited by other authors by ranking the 100 top-cited works. By analyzing characteristics of these articles, we intended to determine what qualities make an orthopaedic article important to the specialty. Finally, we determined if there was a change in level of evidence of studies on this list with time.

Methods Science Citation Index Expanded was searched for citations to articles published in any of the 49 journals in the subject category “ORTHOPEDICS.” Each of the 49 journals was searched separately using the “cited reference search” to determine the 100 most often cited articles. Each article was reviewed for basic information including year of publication, country of origin, source journal of the article, article type, and level of evidence. We categorized the journal article by field of research where possible.

Results The number of citations ranged from 1748 to 353. The 100 most often cited articles in orthopaedic surgery

were published in 11 of the 49 journals, spanning from general to more specific subspecialty journals. The majority of the papers (76) were clinical, with the remaining representing some type of basic science research. The most common level of evidence was IV (42 of the 76 studies). Of the 76 clinical articles, 27 introduced or tested classification systems or outcome measurement tools.

Conclusions Authors aiming to write a highly cited article in an orthopaedic surgery journal will be favored by language of publication, source journal, country of origin, and introduction of a classification scheme or outcome tool.

Introduction

In medicine, the number of times a work is cited by other authors has been established as a widely used and logical measure of how much academic influence an article has had in its subject area [1, 3, 4, 7, 10–13, 16–23, 27, 28, 30]. The reporting of this type of citation analysis is widespread in the medical literature [1, 3, 4, 10, 11, 13, 16–18, 20, 21, 23, 27, 28, 30]. The establishment of a citation rank list across a specialty, comprising many journals specific to an area of medicine, is a more complex process than citation analysis for one journal, although such analyses have been reported in some other areas of medicine [1, 3, 4, 21, 23, 27].

Research in orthopaedic surgery as a specialty has evolved immensely since the first publications in the 19th century. As with all areas of medicine, the direction and evolution of orthopaedic surgery as a specialty have been driven by the publication of the work of peers, long before coining of the term “evidence-based medicine” and our appreciation of the concept [9, 24]. The publication of major orthopaedic-specific journals started more than 100 years ago with *Transactions of the American Orthopaedic*

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Association in 1887 (now evolved into the American and British versions of *The Journal of Bone and Joint Surgery* [29]). Today, there are 49 journals categorized under the topic heading of orthopaedics in Web of Science, which cover all possible subspecialty areas of orthopaedics [25]. These journals range from general clinical journals, to subspecialty-specific journals, to basic science journals. Although many are directly related to the practice of orthopaedic surgery, some are only peripherally related (eg, *Physical Therapy*, *Prosthetics and Orthotics International*).

One way to measure the academic importance of an article is the rate at which the work is quoted or referenced by other authors [7, 11, 16, 19, 22]. The article referenced by another peer-reviewed article receives a “citation.” The number of citations that one article receives is not necessarily a measure of the quality of the research or even its influence on the practice of the author’s or authors’ peers [7]. Nevertheless, it does speak to the readership of the particular article and the influence of the article in generating changes in practice, controversy, discussion, or further research. This is viewed as a direct measure of the recognition an article has received in its field. Citation analysis in specific journals and specific subject areas has become a popular method of assessing the citation impact of a journal, article, or author [1, 3, 4, 7, 10–13, 16–23, 27, 28, 30].

The Institute for Scientific Information (ISI) has been collecting citation and other academic impact information since 1945, and it has been available electronically since 1979. ISI (now a subsidiary of Thomson Corp) calls their newest journal citation system “Science Citation Index Expanded” and it is one of the databases available under the banner of Web of Science [25]. Citation data from peer-reviewed articles are indexed from more than 10,000 high-impact journals not only from the sciences and social sciences but also from the arts and humanities.

We used the electronic version of this database to determine which published articles in orthopaedic journals have been cited most often by other authors by ranking the 100 top-cited works. By analyzing characteristics of these articles, we intended to determine what qualities make an orthopaedic article important to the specialty. Finally, we determined if there was a change in level of evidence of studies included in this list with time.

Materials and Methods

In April 2009, we searched the Science Citation Index Expanded for citations to articles published in any of the 49 journals (Table 1) in the subject category “ORTHO-PEDICS” of the 2008 Journal Citation Report Science

Table 1. List of considered journals under the topic heading “Orthopaedics” on Web of Science

Journal
Acta Orthopaedica
American Journal of Sports Medicine
Archives of Orthopaedic and Trauma Surgery
Arthroscopy-The Journal of Arthroscopic and Related Surgery
BMC Musculoskeletal Disorders
Clinical Biomechanics
Clinical Journal of Sports Medicine
Clinical Orthopaedics and Related Research
Connective Tissue Research
Current Orthopaedics
European Spine Journal
Foot & Ankle International
Gait & Posture
Hand Clinics
Hip International
Injury-International Journal of the Care of the Injured
International Orthopaedics
Isokinetics and Exercise Science
Journal of the American Academy of Orthopaedic Surgeons
Journal of the American Podiatric Medical Association
Journal of Arthroplasty
Journal of Back and Musculoskeletal Rehabilitation
Journal of Bone and Joint Surgery-American Volume
Journal of Bone and Joint Surgery-British Volume
Journal of Hand Surgery-American Volume
Journal of Hand Surgery-European Volume
Journal of Hand Therapy
Journal of Orthopaedic Research
Journal of Orthopaedic Science
Journal of Orthopaedic & Sports Physical Therapy
Journal of Orthopaedic Trauma
Journal of Pediatric Orthopaedics
Journal of Pediatric Orthopaedics-Part B
Journal of Shoulder and Elbow Surgery
Journal of Spinal Disorders & Techniques
Knee
Knee Surgery Sports Traumatology Arthroscopy
Orthopaedic Clinics of North America
Orthopaedic Nursing
Orthopäde
Orthopedics
Osteoarthritis and Cartilage
Physical Therapy
Prosthetics and Orthotics International
Revue de Chirurgie Orthopedique et Reparatrice de L’Appareil Moteur
Spine
Sportverletzung-Sportschaden

Table 1. continued

Journal
Zeitschrift für Orthopädie und ihre Grenzgebiete
Zeitschrift für Orthopädie und Unfallchirurgie

Edition. Of the 49 journals, 44 are published in English, and five are published in another language. ORTHOPEDICS is one of nearly 200 subject categories predetermined in the Journal Citation Reports section of Web of Science [25]. Each of the 49 journals was searched separately using the “cited reference search,” one of the many options through ISI Web of Knowledge [25]. The top 100 cited articles from the 49 journals were recorded.

Each article in the most cited 100 was reviewed and basic information collected, including authors, year of publications, source journal of the article, geographic origin of the authors, article type (basic science article, clinical research article), article subtype (basic science-biomechanics, basic science-animal research, basic science-in vitro study, clinical-randomized controlled trial, prospective cohort study, case series, review article, case report, or expert opinion), and level of evidence for clinical articles based on guidelines published by *The Journal of Bone and Joint Surgery American Volume* [29]. The level of evidence reflects the relative risk of bias in a study, not necessarily its inherent quality. The level of evidence was determined by consensus by the first (KAL) and senior (PJO) authors. We also determined whether each article was methodologic if it introduced or tested a classification system or scoring system (ie, outcome score).

We categorized the journal article by field of research where possible. Field of research was by clinical subspecialty for clinical articles (trauma/fracture healing, oncology, hip and knee arthroplasty, sports medicine and arthroscopy, spine, physical therapy and rehabilitation, pediatric orthopaedics, hand and upper extremity, foot and ankle) and by one of six categories for basic science articles (stem cell, cartilage tissue, bone tissue, ligament tissue, tendon tissue, implants).

We compared categorical variables (ie, level of evidence by decade of publication) between the groups using the Fisher exact test. Comparisons of means between groups were performed using the Wilcoxon rank sum test. All statistics were performed with SAS[®] statistical software (Version 9.1; SAS Institute Inc, Cary, NC).

Results

The top five articles were each cited more than 1000 times, and the span in the top 100 was from 1748 to 353 citations

(Table 2). The publication years of the most cited articles span from 1948 to 2000, with the 1980 s accounting for the most articles, with 42 (Fig. 1A). Only one article was published in the new millennium, in 2000. The difference in mean number of citations by decade of publication is less pronounced than the difference in number of articles published by decade (Fig. 1). All the articles were published in English. The articles were published in 11 of the 49 journals, including general and subspecialty journals (Table 3).

The articles on the most cited 100 list originated all over the world. The number of articles by country of origin for these works was led by the United States ($n = 72$), followed by Great Britain ($n = 9$), Sweden ($n = 5$), and Canada ($n = 3$). Russia, Scotland, France, and The Netherlands each contributed two articles, while India, Norway, and Denmark each contributed an article to the list. The top first author was C.S. Neer, with lead authorship in five articles in the top 100 list. Nine other authors had two lead authorships (G. Waddell, R.H. Salter, F.R. Noyes, H.J. Mankin, M.P. Kabada, J.H. Insall, G.A. Ilizarov, W.H. Harris, and W.F. Enneking). The author with the top article on this list (W.H. Harris) had two lead authorships and five senior authorships.

The majority of the papers (76) were clinical, with the remaining papers representing some type of basic science research (in vitro, biomechanical, or animal studies). Of the 76 clinical articles, 27 introduced or tested classification systems or outcome measurement tools. The mean number of citations for those methodologic papers (677 citations per paper) was larger ($p < 0.001$) than that for non-methodologic papers (455 citations per paper). The 76 clinical papers were from various subspecialty areas, the most common being lower extremity arthroplasty ($n = 21$) and sports medicine and arthroscopy ($n = 22$) (Fig. 2). The nonclinical papers were primarily basic science articles dealing with bone tissue ($n = 11$) (Fig. 3).

Of the 76 clinical articles, the most common type was uncontrolled case series (43) (Table 4). There were no randomized controlled trials in the most cited 100 list; however, the 96th ranked article (van Tulder et al., Table 2) met the criteria for a Level I study by providing a systematic review of randomized controlled trials. The most common level of evidence was IV, with 42 of the 76 studies falling into this category (Fig. 4). The level of evidence of the articles was similar ($p = 0.52$) by decade of publication.

Discussion

In medical literature, the study of the number of times other authors reference an article is one measure of the influence

Table 2. Top 100 cited articles published in journals listed under the topic heading “Orthopedics” on Web of Science

Rank	Article	Number of citations
1	Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. <i>J Bone Joint Surg Am.</i> 1969;51:737–755.	1748
2	Brooker AF, Bowerman JW, Robinson RA, Riley LH Jr. Ectopic ossification following total hip replacement: incidence and a method of classification. <i>J Bone Joint Surg Am.</i> 1973;55:1629–1632.	1126
3	Mankin HJ, Dorfman H, Lippiello L, Zarins A. Biomechanical and metabolic abnormalities in articular cartilage from osteo-arthritic human hips: II. Correlation of morphology with biomechanical and metabolic data. <i>J Bone Joint Surg Am.</i> 1971;53:523–537.	1073
4	Gustilo RB, Anderson JT. Prevention of infection in treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. <i>J Bone Joint Surg Am.</i> 1976;58:453–458.	1069
5	Gruen TA, McNeice GM, Amstutz HC. “Modes of failure” of cemented stem-type femoral components: radiographic analysis of loosening. <i>Clin Orthop Relat Res.</i> 1979;141:17–27.	1033
6	Roland M, Morris R. A study of the natural history of back pain. Part I: Development of a reliable and sensitive measure of disability in low-back pain. <i>Spine (Phila Pa 1976).</i> 1983;8:141–144.	979
7	Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of the Knee Society clinical rating system. <i>Clin Orthop Relat Res.</i> 1989;248:13–14.	914
8	Neer CS 2nd. Anterior acromioplasty for chronic impingement syndrome in the shoulder: a preliminary report. <i>J Bone Joint Surg Am.</i> 1972;54:41–50.	865
9	Bohannon RW, Smith MB. Interrater reliability of a modified Ashworth scale of muscle spasticity. <i>Phys Ther.</i> 1987;67:206–207.	863
10	Caplan AI. Mesenchymal stem cells. <i>J Orthop Res.</i> 1991;9:641–650.	844
11	Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. <i>Clin Orthop Relat Res.</i> 1987;214:160–164.	838
12	DeLee JG, Charnley J. Radiological demarcation of cemented sockets in total hip replacement. <i>Clin Orthop Relat Res.</i> 1976;121:20–32.	834
13	Carter DR, Hayes WC. The compressive behavior of bone as a two-phase porous structure. <i>J Bone Joint Surg Am.</i> 1977;59:954–962.	796
14	Farndale RW, Sayers CA, Barrett AJ. A direct spectrophotometric micro-assay for sulfated glycosaminoglycans in cartilage cultures. <i>Connect Tissue Res.</i> 1982;9:247–248.	778
15	Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. <i>Am J Sports Med.</i> 1982;10:150–154.	685
16	Boden SD, Davis DO, Dina TS, Patronas NJ, Wiesel SW. Abnormal magnetic-resonance scans of the lumbar spine in asymptomatic subjects: a prospective investigation. <i>J Bone Joint Surg Am.</i> 1990;72:403–408.	683
17	Rubin CT, Lanyon LE. Regulation of bone formation by applied dynamic loads. <i>J Bone Joint Surg Am.</i> 1984;66:397–402.	667
18	Salter RB, Harris WR. Injuries involving the epiphyseal plate. <i>J Bone Joint Surg Am.</i> 1963;45:587–622.	666
19	Outerbridge RE. The etiology of chondromalacia patellae. <i>J Bone Joint Surg Br.</i> 1961;43:752–757.	659
20	Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. <i>Foot Ankle Int.</i> 1994;15:349–353.	658
21*	Goldring SR, Schiller AL, Roelke M, Rourke CM, O’Neil DA, Harris WH. The synovial-like membrane at the bone-cement interface in loose total hip replacements and its proposed role in bone lysis. <i>J Bone Joint Surg Am.</i> 1983;65:575–584.	651
	Albrektsson T, Branemark PI, Hansson HA, Lindstrom J. Osseointegrated titanium implants: requirements for ensuring a long-lasting, direct bone-to-implant anchorage in man. <i>Acta Orthop Scand.</i> 1981;52:155–170.	651
23	Tegner Y, Lysholm J. Rating systems in the evaluation of knee ligament injuries. <i>Clin Orthop Relat Res.</i> 1985;198:43–49.	633
24	Fairbank TJ. Knee joint changes after meniscectomy. <i>J Bone Joint Surg Br.</i> 1948;30:664–670.	631
25	Jarcho M. Calcium phosphate ceramics as hard tissue prosthetics. <i>Clin Orthop Relat Res.</i> 1981;157:259–278.	615
26	Schmalzried TP, Jasty M, Harris WH. Periprosthetic bone loss in total hip arthroplasty: polyethylene wear debris and the concept of the effective joint space. <i>J Bone Joint Surg Am.</i> 1992;74:849–863.	603

Table 2. continued

Rank	Article	Number of citations
27*	Wakitani S, Goto T, Pineda SJ, Young RG, Mansour JM, Caplan AI, Goldberg VM. Mesenchymal cell-based repair of large, full-thickness defects of articular cartilage. <i>J Bone Joint Surg Am.</i> 1994;76:579–592.	602
	Ilizarov GA. The tension-stress effect on the genesis and growth of tissues. Part I: The influence of stability of fixation and soft-tissue preservation. <i>Clin Orthop Relat Res.</i> 1989;238:249–281.	602
29	Engh CA, Bobyn JD, Glassman AH. Porous-coated hip replacement: the factors governing bone ingrowth, stress shielding, and clinical results. <i>J Bone Joint Surg Br.</i> 1987;69:45–55.	597
30	Waddell G. 1987 Volvo award in clinical sciences: A new clinical model for the treatment of low-back pain. <i>Spine (Phila Pa 1976).</i> 1987;12:632–644.	567
31	Younger EM, Chapman MW. Morbidity at bone graft donor sites. <i>J Orthop Trauma.</i> 1989;3:192–195.	566
32	Stauffer RN. 10-year follow-up study of total hip replacement: with particular reference to roentgenographic loosening of the components. <i>J Bone Joint Surg Am.</i> 1982;64:983–990.	559
33	Phalen GS. The carpal-tunnel syndrome: seventeen years' experience in diagnosis and treatment of six hundred fifty-four hands. <i>J Bone Joint Surg Am.</i> 1966;48:211–228.	544
34	Livermore J, Ilstrup D, Morrey B. Effect of femoral head size on wear of the polyethylene acetabular component. <i>J Bone Joint Surg Am.</i> 1990;72:518–528.	541
35	Noyes FR, Butler DL, Grood ES, Zernicke RF, Hefzy MS. Biomechanical analysis of human ligament grafts used in knee-ligament repairs and reconstructions. <i>J Bone Joint Surg Am.</i> 1984;66:344–352.	531
36	Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. <i>Spine (Phila Pa 1976).</i> 1983;8:817–831.	524
37	Ilizarov GA. The tension-stress effect on the genesis and growth of tissues: Part II. The influence of the rate and frequency of distraction. <i>Clin Orthop Relat Res.</i> 1989;239:263–285.	510
38	Neer CS 2nd. Displaced proximal humeral fractures: I. Classification and evaluation. <i>J Bone Joint Surg Am.</i> 1970;52:1077–1089.	498
39	Enneking WF, Dunham W, Gebhardt MC, Malawar M, Pritchard DJ. A system for the functional evaluation of reconstructive procedures after surgical treatment of tumors of the musculoskeletal system. <i>Clin Orthop Relat Res.</i> 1993;286:241–246.	496
40	Rosenberg L. Chemical basis for histological use of safranin O in study of articular cartilage. <i>J Bone Joint Surg Am.</i> 1971;53:69–82.	493
41	Mankin HJ. The response of articular cartilage to mechanical injury. <i>J Bone Joint Surg Am.</i> 1982;64:460–466.	485
42	Insall JN, Ranawat CS, Aglietti P, Shine J. Comparison of four models of total knee-replacement prostheses. <i>J Bone Joint Surg Am.</i> 1976;58:754–765.	476
43	Sutherland CJ, Wilde AH, Borden LS, Marks KE. A ten-year follow-up of one hundred consecutive Muller curved-stem total hip-replacement arthroplasties. <i>J Bone Joint Surg Am.</i> 1982;64:970–982.	475
44	D'Aubigne RM, Postel M. Functional results of hip arthroplasty of hip arthroplasty with acrylic prosthesis. <i>J Bone Joint Surg Am.</i> 1954;36:451–475.	474
45*	Salter RB, Simmonds DF, Malcolm BW, Rumble EJ, Macmichael D, Clements ND. The biological effect of continuous passive motion on the healing of full-thickness defects in articular cartilage: an experimental investigation in the rabbit. <i>J Bone Joint Surg Am.</i> 1980;62:1232–1251.	464
	Dahlin DC, Coventry MB. Osteogenic sarcoma: a study of six hundred cases. <i>J Bone Joint Surg Am.</i> 1967;49:101–110.	464
	Yasko AW, Lane JM, Fellingner EJ, Rosen V, Wozney JM, Wang EA. The healing of segmental bone defects, induced by recombinant human bone morphogenetic protein (RHBMP-2): a radiographic, histological, and biomechanical study in rats. <i>J Bone Joint Surg Am.</i> 1992;74:659–670.	464
48	Rowe CR, Patel D, Southmayd WW. The Bankart procedure: a long-term end-result study. <i>J Bone Joint Surg Am.</i> 1978;60:1–16.	462
49	Sah RL, Kim YJ, Doong JY, Grodzinsky AJ, Plaas AH, Sandy JD. Biosynthetic response of cartilage explants to dynamic compression. <i>J Orthop Res.</i> 1989;7:619–636.	460
50	Singh M, Nagrath AR, Maini PS. Changes in trabecular pattern of upper end of the femur as an index of osteoporosis. <i>J Bone Joint Surg Am.</i> 1970;52:457–467.	458
51	Bartel DL, Bicknell VL, Wright TM. The effect of conformity, thickness, and material on stresses in ultra-high molecular weight components for total joint replacement. <i>J Bone Joint Surg Am.</i> 1986;68:1041–1051.	457

Table 2. continued

Rank	Article	Number of citations
52	Goldenberg RR, Campbell CJ, Bonfiglio M. Giant-cell tumor of bone: an analysis of two hundred eighteen cases. <i>J Bone Joint Surg Am.</i> 1970;52:619–664.	455
53	Chandler HP, Reineck FT, Wixson RL, McCarthy JC. Total hip replacement in patients younger than thirty years old: a five-year follow-up study. <i>J Bone Joint Surg Am.</i> 1981;63:1426–1434.	454
54	Weber H. Lumbar-disc herniation: a controlled, prospective study with ten years of observation. <i>Spine (Phila Pa 1976).</i> 1983;8:131–140.	452
55	Shelbourne KD, Nitz P. Accelerated rehabilitation after anterior cruciate ligament reconstruction. <i>Am J Sports Med.</i> 1990;18:292–299.	450
56	Neer CS 2nd. Impingement lesions. <i>Clin Orthop Relat Res.</i> 1983;173:70–77.	445
57	Butler DL, Noyes FR, Grood ES. Ligamentous restraints to anterior-posterior drawer in the human knee: a biomechanical study. <i>J Bone Joint Surg Am.</i> 1980;62:259–270.	441
58	Enneking WF, Spanier SS, Goodman MA. A system for the surgical staging of musculoskeletal sarcoma. <i>Clin Orthop Relat Res.</i> 1980;153:106–120.	440
59	Biering-Sorensen F. Physical measurements as risk indicators for low-back trouble over a one-year period. <i>Spine (Phila Pa 1976).</i> 1984;9:106–119.	438
60*	Ficat RP. Idiopathic bone necrosis of the femoral head: early diagnosis and treatment. <i>J Bone Joint Surg Br.</i> 1985;67:3–9.	434
	Ewald FC. The Knee Society total knee arthroplasty roentgenographic evaluation and scoring system. <i>Clin Orthop Relat Res.</i> 1989;248:9–12.	434
62*	Bigos SJ, Battie MC, Spengler DM, Fisher LD, Fordyce WE, Hansson TH, Nachemson AL, Wortley MD. A prospective study of work perceptions and psychosocial factors affecting the report of back injury. <i>Spine (Phila Pa 1976).</i> 1991;16:1–6.	433
	Peterson L, Minas T, Brittberg M, Nilsson A, Sjogren-Jansson E, Lindahl A. Two- to 9-year outcome after autologous chondrocyte transplantation of the knee. <i>Clin Orthop Relat Res.</i> 2000;374:212–234.	433
64	Smith GW, Robinson RA. The treatment of certain cervical-spine disorders by anterior removal of the intervertebral disc and interbody fusion. <i>J Bone Joint Surg Am.</i> 1958;40:607–624.	429
65	Harris WH, McCarthy JC Jr, O'Neill DA. Femoral component loosening using contemporary techniques of femoral cement fixation. <i>J Bone Joint Surg Am.</i> 1982;64:1063–1067.	425
66	Arendt E, Dick R. Knee injury patterns among men and women in collegiate basketball and soccer: NCAA data and review of literature. <i>Am J Sports Med.</i> 1995;23:694–701.	424
67*	Beckenbaugh RD, Ilstrup DM. Total hip arthroplasty: a review of three hundred and thirty-three cases with long follow-up. <i>J Bone Joint Surg Am.</i> 1978;60:306–313.	423
	McKibbin B. The biology of fracture healing in long bones. <i>J Bone Joint Surg Br.</i> 1978;60:150–162.	423
69	Johnston RC, Fitzgerald RH Jr, Harris WH, Poss R, Muller ME, Sledge CB. Clinical and radiographic evaluation of total hip replacement: a standard system of terminology for reporting results. <i>J Bone Joint Surg Am.</i> 1990;72:161–168.	421
70	Noyes FR, Moar PA, Matthews DS, Butler DL. The symptomatic anterior cruciate deficient knee. Part I: The long-term functional disability in athletically active individuals. <i>J Bone Joint Surg Am.</i> 1983;65:154–162.	420
71	Kadaba MP, Ramakrishnan HK, Wootten ME. Measurement of lower-extremity kinematics during level walking. <i>J Orthop Res.</i> 1990;8:383–392.	419
72	Jowsey J, Kelly PJ, Riggs BL, Bianco AJ Jr, Scholz DA, Gershon-Cohen J. Quantitative microradiographic studies of normal and osteoporotic bone. <i>J Bone Joint Surg Am.</i> 1965;47:785–806.	414
73	Neer CS 2nd, Foster CR. Inferior capsular shift for involuntary inferior and multidirectional instability of the shoulder: a preliminary report. <i>J Bone Joint Surg Am.</i> 1980;62:897–908.	408
74	Shapiro F, Koide S, Glimcher MJ. Cell origin and differentiation in the repair of full-thickness defects of articular cartilage. <i>J Bone Joint Surg Am.</i> 1993;75:532–553.	403
75	Neer CS 2nd, Watson KC, Stanton FJ. Recent experience in total shoulder replacement. <i>J Bone Joint Surg Am.</i> 1982;64:319–337.	400
76	Merchant AC, Mercer RL, Jacobsen RH, Cool CR. Roentgenographic analysis of patellofemoral congruence. <i>J Bone Joint Surg Am.</i> 1974;56:1391–1396.	399
77	Frymoyer JW, Pope MH, Clements JH, Wilder DG, Macpherson B, Ashikaga T. Risk factors in low-back pain: an epidemiological survey. <i>J Bone Joint Surg Am.</i> 1983;65:213–218.	398

Table 2. continued

Rank	Article	Number of citations
78*	Daniel DM, Stone ML, Dobson BE, Fithian DC, Rossman DJ, Kaufman KR. Fate of the ACL-injured patient: a prospective outcome study. <i>Am J Sports Med.</i> 1994;22:632–644.	397
	Murray MP, Drought AB, Kory RC. Walking patterns of normal men. <i>J Bone Joint Surg Am.</i> 1964;46:335–360.	397
80	Jones HH, Priest JD, Hayes WC, Tichenor CC, Nagel DA. Humeral hypertrophy in response to exercise. <i>J Bone Joint Surg Am.</i> 1977;59:204–208.	393
81	Poppen NK, Walker PS. Normal and abnormal motion of the shoulder. <i>J Bone Joint Surg Am.</i> 1976;58:195–201.	391
82	James SL, Bates BT, Osternig LR. Injuries to runners. <i>Am J Sports Med.</i> 1978;6:40–50.	385
83	Levine DW, Simmons BP, Koris MJ, Daltroy LH, Hohl GG, Fossel AH, Katz JN. A self-administered questionnaire for the assessment of severity of symptoms and functional status in carpal tunnel syndrome. <i>J Bone Joint Surg Am.</i> 1993;75:1585–1592.	382
84	Turkel SJ, Panio MW, Marshall JL, Girgis FG. Stabilizing mechanisms preventing anterior dislocation of the glenohumeral joint. <i>J Bone Joint Surg Am.</i> 1981;63:1208–1217.	380
85	Rodeo SA, Arnoczky SP, Torzilli PA, Hidaka C, Warren RF. Tendon-healing in a bone tunnel: a biomechanical and histological study in the dog. <i>J Bone Joint Surg Am.</i> 1993;75:1795–1803.	370
86	Tapper EM, Hoover NW. Late results after meniscectomy. <i>J Bone Joint Surg Am.</i> 1969;51:517–526 passim.	368
87*	Harrington PR. Treatment of scoliosis: correction and internal fixation by spine instrumentation. <i>J Bone Joint Surg Am.</i> 1962;44:591–610.	365
	Waddell G, McCulloch JA, Kummel E, Venner RM. Nonorganic physical signs in low-back pain. <i>Spine (Phila Pa 1976).</i> 1980;5:117–125.	365
89*	Malchau H, Herberts P, Ahnfelt L. Prognosis of total hip replacement in Sweden: follow-up of 92,675 operations performed 1978–1990. <i>Acta Orthop Scand.</i> 1993;64:497–506.	363
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91	Verbiest H. A radicular syndrome from developmental narrowing of the lumbar vertebral canal. <i>J Bone Joint Surg Br.</i> 1954;36:230–237.	361
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94*	Buckwalter JA, Mankin HJ. Instructional Course Lectures, The American Academy of Orthopaedic Surgeons. Articular cartilage. Part II: Degeneration and osteoarthritis, repair, regeneration, and transplantation <i>J Bone Joint Surg Am.</i> 1997;79:612–632.	358
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96	van Tulder MW, Koes BW, Bouter LM. Conservative treatment of acute and chronic nonspecific low back pain: a systematic review of randomized controlled trials of the most common interventions. <i>Spine (Phila PA 1976).</i> 1997;22:2128–2156.	357
97	Trueta J, Harrison MH. The normal vascular anatomy of the femoral head in adult man. <i>J Bone Joint Surg Br.</i> 1953;35:442–461.	356
98	Goodship AE, Kenwright J. The influence of induced micromovement upon the healing of experimental tibial fractures. <i>J Bone Joint Surg Br.</i> 1985;67:650–655.	354
99*	Kadaba MP, Ramakrishnan HK, Wootten ME, Gainey J, Gorton G, Cochran GV. Repeatability of kinematic, kinetic, and electromyographic data in normal adult gait. <i>J Orthop Res.</i> 1989;7:849–860.	353
	Winkquist RA, Hansen ST Jr, Clawson DK. Closed intramedullary nailing of femoral fractures: a report of five hundred and twenty cases. <i>J Bone Joint Surg Am.</i> 1984;66:529–539.	353

* Two or more citations tied for the same rank.

of the publication, and this type of citation analysis is widespread [1, 3, 4, 7, 10–13, 15–23, 27, 28, 30]. The evaluation of specialty-wide citation analysis has been

reported in other areas of medicine [1, 3, 4, 21, 23, 27]. We aimed to determine which published articles in orthopaedic journals have exerted the most citation influence on the

Fig. 1A–B The graphs show the (A) number of articles on the top 100 list by decade of publication and (B) mean number of citations by decade of publication for articles on the top 100 list.

Table 3. Number of articles on top 100 list by source journal

Journal	Number of articles
Journal of Bone and Joint Surgery-American Volume	54
Clinical Orthopaedics and Related Research	13
Spine	9
Journal of Bone and Joint Surgery-British Volume	9
American Journal of Sports Medicine	5
Journal of Orthopaedic Research	4
Acta Orthopaedica	2
Connective Tissue Research	1
Journal of Orthopaedic Trauma	1
Foot & Ankle International	1
Physical Therapy	1

specialty by ranking the 100 most cited works. By analyzing characteristics of these articles, we aimed to determine what qualities make an orthopaedic article important to peers in the specialty. Finally, we aimed to

determine if the level of evidence of highly cited studies is changing by determining if there was a change in included studies in this list with time.

There are some intrinsic problems with using this method alone to evaluate the academic importance of one article, an author's or authors' publications, or the performance of a journal overall. First, this type of citation analysis does not account for self-citation, citations in textbooks and lectures, and an author's or authors' potential preference to cite articles in the journal in which they seek to publish their work [15, 26]. Second, there is a clear time effect in citation analysis, with the most recent articles being at a disadvantage [5, 6, 8]. The time from publication played an apparent role here, with the 1980s being the most prominent decade of publication for the most cited 100. Despite evolving focus on improvement of quality of research and the importance of evidence-based practice, recent articles are at a clear disadvantage in citation analysis regardless [2]. Third, this study is limited by the categorization of journals in Web of Science. By design, only articles in the 49 journals categorized as

Fig. 2 A graph shows the articles by clinical subspecialty (n = 76).

Fig. 3 A graph shows the number of articles in the top 100 list by nonclinical area of research (n = 24).

Table 4. Breakdown by study type for 76 clinical articles on the top 100 list

Clinical study type	Number of articles
Randomized controlled trial	0
Nonrandomized controlled trial	2
Cohort study	8
Case control study	8
Case series	43
Case report	0
Review article	8
Expert opinion	7

“orthopaedics” journals were considered. Although this represents a long and complete list of orthopaedic-specific journals, articles in the topic area of orthopaedic surgery published in general medical and basic science literature

were not considered here, likely leaving out work that has been influential in the specialty [27, 28]. Fourth, language of publication plays a major role, with an obvious bias for articles published in English language journals. Fifth, there are biases inherent in the age of the database, as any articles published in the 19th or early 20th century would be excluded, which likely causes some true ‘classic’ articles to be excluded. Finally, Kuhnian philosophy [14] would tell us that in a scientific community there is a tendency for adherence to a paradigm. In this context that would mean that there is ‘snowball effect’ to citations, as other authors are more likely to cite it because of previous citations, rather than for its content or quality.

We ranked the top 100 articles by number of citations in the specialty of orthopaedic surgery. The top article had 1748 citations, with all of the top five articles outperforming the top-cited article in general surgery in a similar review published in 2002 [21]. Similarly, the most cited

Fig. 4 A graphs shows the level of evidence based on *The Journal of Bone and Joint Surgery American Volume* guidelines for the 76 clinical articles in the top 100 list.

article in plastic surgery garnered 631 citations, and the top cited article in emergency medicine had 335 [17, 30]. With the lowest number of citations on the top 100 list at 353, every article on the list can be considered a ‘citation classic’ by the frequently used, but somewhat arbitrary, marker of 100 citations as the benchmark [18, 20].

The study characteristics revealed here echo those found in similar reviews. The majority of articles originated in the United States, which also has been found in reviews of Anesthesia, Plastic Surgery, Emergency Medicine, and General Surgery [3, 17, 21, 30], indicating that American authors may be at an advantage. Although level of evidence has not been reviewed frequently in other citation analyses, the propensity for levels IV and V studies was echoed in the review of Plastic Surgery literature. The dominance of clinical, rather than basic science articles, also was noted in other reviews [3, 17, 21, 30].

Evaluation of the most cited articles here and in other similar reviews gives some clues regarding what drives article citation. In other citation analyses, the introduction of a commonly used classification or scoring system is a major factor in propelling citation by other authors. This was evident in the review of general surgical journals (“Transection of the Oesophagus for Bleeding Oesophageal Varices,” which introduced the novel modification of the Child’s classification for portal hypertension), plastic surgery (“Hemangiomas and Vascular Malformations in Infants and Children: A Classification Based on Endothelial Characteristics”), and *The Journal of Trauma* (“Injury Severity Score: Method for Describing Patients with Multiple Injuries and Evaluating Emergency Care”) [17, 20, 21]. We found not only a high proportion of articles introducing classification and scoring system overall (27 of 76 clinical articles), but also a substantially higher number of citations per article for those articles compared with those not introducing such a system.

Our review of the most cited articles in orthopaedic surgery may be worthwhile for several reasons. First, our observations suggest the authors of citation classics in orthopaedics have produced more highly cited articles than many of their colleagues in other specialties. Second, we have identified several attributes of articles successful in citation, indicating that journal and country of origin are very important factors. Finally, despite considerable evolution in the quality of research in orthopaedics in recent decades, we identified only one Level 1 study among the most cited works in orthopaedics. Although the future of orthopaedic citation may be in higher level of evidence studies, however, this has not yet been an important determinant of citation in orthopaedic articles.

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