



Contents lists available at ScienceDirect

Journal of Hand Surgery Global Online

journal homepage: www.JHSGO.org

Original Research

Fifty Most-Cited Research Articles in Elbow Surgery: A Modern Reading List



Jessica L. Baylor, BS, * A. Michael Luciani, MD, * Jeremy S. Tokash, MD, MHA, * Brian K. Foster, MD, * Joel C. Klena, MD, * Louis C. Grandizio, DO *

* Department of Orthopaedic Surgery, Geisinger Musculoskeletal Institute, Geisinger Commonwealth School of Medicine, Danville, PA

ARTICLE INFO

Article history:

Received for publication July 1, 2022

Accepted in revised form March 7, 2023

Available online April 12, 2023

Key words:

Bibliometric analysis

Citations

Education

Elbow surgery

References

Purpose: Bibliometric analysis is a common method for evaluating current trends within a scientific field. The primary aim of this study was to define and analyze the 50 most frequently cited articles in the field of elbow surgery, both of all time and those published during the 21st century.

Methods: We searched the Journal Citation Report to identify articles related to elbow surgery within academic journals. Articles were sorted by total citations. The overall top 50 articles and those published since 2000 were identified, and data were collected, including title, journal of publication, publication year, country of publication, citation density, level of evidence, article type, institution, and sex of the lead and senior authors, and inclusion on the reference list for the Orthopaedic In-Training Examination within the last 5 years. Descriptive statistics were reported, and correlation analysis was performed using Spearman test.

Results: For the most-cited elbow surgery articles, “fracture” was overall the most reported topic, whereas “lateral epicondylitis” and “fracture” were equal for those published since 2000. The United States was the most represented overall and for articles published since 2000. Women comprised 1/50 (2%) of lead authors overall, increasing to 8/50 (16%) for articles published during the 21st century. Most articles in during both periods contained level IV evidence, with level I evidence appearing infrequently (4%). Six percent of the most-cited articles of all time had appeared on the reference list of the Orthopaedic In-Training Examination within the past 5 years.

Conclusions: The top 50 most-cited elbow surgery articles often assess fracture and lateral epicondylitis, most commonly originating from the United States. Level IV retrospective series comprises over half of the articles on this list. Women remain underrepresented as authors.

Clinical Relevance: This study provides a modern reading list for upper-extremity surgeons about impactful elbow surgery articles.

Copyright © 2023, THE AUTHORS. Published by Elsevier Inc. on behalf of The American Society for Surgery of the Hand. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Bibliometric analysis is a common method for evaluating article trends within a scientific field. Medical specialties often use it to identify and assess frequently cited and influential peer-reviewed publications.^{1–4} Within orthopedics, this type of analysis has been performed within multiple subspecialties, including sports medicine, adult reconstruction, pediatrics, and upper-extremity

Declaration of interests: No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

Corresponding author: Louis C. Grandizio, DO, Department of Orthopaedic Surgery, Geisinger Musculoskeletal Institute, Geisinger Commonwealth School of Medicine, 16 Woodbine Lane, Danville, PA 17821.

E-mail address: chris.grandizio@gmail.com (L.C. Grandizio).

<https://doi.org/10.1016/j.jhsg.2023.03.009>

2589-5141/Copyright © 2023, THE AUTHORS. Published by Elsevier Inc. on behalf of The American Society for Surgery of the Hand. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

surgery.^{5–18} Bibliometric analysis may be of increasing value as the number of scientific publications increases annually at a rate of approximately 4%.¹⁹

Although publication trends within elbow surgery were assessed in the 2010s, continued journal and article volume expansions have introduced impactful articles on elbow surgery.¹⁰ Additionally, as the field of orthopedics progresses toward sex parity, it is increasingly important to evaluate the corresponding representation to authorship.²⁰ Multiple orthopedic subspecialties have reported an increase in female authorship in recent years, including pediatrics and hand surgery.^{21,22} However, sex disparity is still reported among the lead authorship of orthopedic research, especially within adult reconstruction.^{23,24}

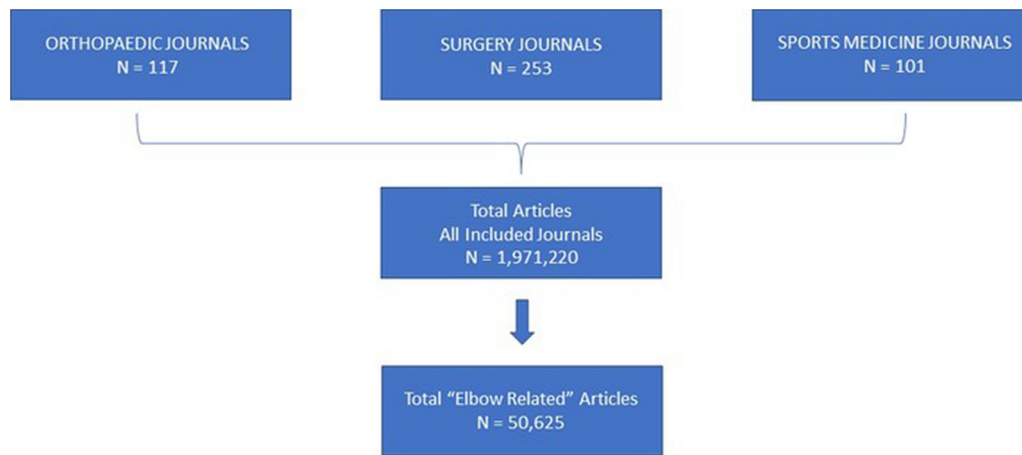


Figure 1. Flowchart of acquisition of elbow-related articles from the Web of Science Journal Citation Reports.

Previous studies have shown correlations between Orthopaedic In-Training Examination (OITE) scores and American Board of Orthopaedic Surgery Part one pass rates.^{25–27} Recently, the American Academy of Orthopaedic Surgeons (AAOS) and American Board of Orthopaedic Surgery have started to work together to ensure that material tested on the OITE directly reflects expected knowledge on the American Board of Orthopaedic Surgery.²⁸ Accordingly, there have been efforts by both residency programs and researchers to understand better the content tested on the OITE.^{27,29–34} However, to the authors' knowledge, no previous studies compare the top 50 most frequently cited articles from a subspecialty to references on the OITE.

The purpose of this investigation was to define and analyze the top 50 most frequently cited articles related to elbow surgery, both of all time and those published within the 21st century. As secondary aims, we assessed the trends in female authorship as part of the bibliometric analysis and to define the relationship between high-impact elbow surgery articles and the OITE reference list.

Materials and Methods

In April 2022, we searched the Journal Citation Report from the Institute for Scientific Information to identify articles related to elbow surgery within peer-reviewed academic journals. Using the Web of Science predetermined journal categories, we identified 117 journal titles in "ORTHOPEDECS," 101 journal titles in "SPORTS SCIENCES," and 253 journal titles in "SURGERY" within the Science Citation Index Expanded and Emerging Sources Citation Index databases. After removing duplicates, we identified 471 journals that contained possible elbow publications (Fig. 1).

Following the methodology previously reported by Huo et al.,¹⁰ articles were identified using the Web of Science by entering each journal into the search engine using the "OR" function, which resulted in 1,971,220 total articles. Articles were sorted by total citations and screened for relevance for elbow surgery through the following search terms: (1) "elbow," (2) "ulna," (3) "ulnar," (4) "radial," (5) "radius," (6) "humerus," or (7) "biceps." These search terms were intentionally broad in an effort to avoid unintentionally excluding articles. This yielded 50,625 articles (Fig. 1). The 50 most-cited articles overall and those published since 2000 were compiled, and demographic data were collected, including title, journal of publication, publication year, country of publication, absolute citation number, citation density, level of evidence, and institution of lead and senior authors. Citation density was

calculated by dividing the total number of citations by the years from publication.^{2,10} Articles were further classified by elbow topic, including arthroplasty, fracture, arthroscopy, distal biceps, biomechanics, lateral epicondylitis, instability/stiffness, cubital tunnel, nerve, physical exam/patient-reported outcomes, more than one, and other (including exercise, pain, dislocation, and ligamentous reconstruction). Sex of lead and last authors were also recorded based on name and/or web search for institutional photos using a previously established methodology.³⁵ Titles were then searched for inclusion on the reference list for all OITE questions within the last 5 years.

Descriptive statistics were performed using chi-square test (or Fisher exact test where appropriate) and a two-tailed independent sample *t* test for categorical and continuous variables, respectively. Due to the nonparametric data, correlation analysis was performed using the Spearman test to investigate the relationship between citation density, impact factor, and level of evidence.¹⁰ A *P* value <.05 was considered statistically significant.

Results

Article details for the most-cited elbow articles of all time and those published since 2000 are included in Tables 1 and 2. Table 3 details the articles' demographics. "Fracture" was the most reported topic overall, whereas "lateral epicondylitis" and "fracture" were equal in those articles published since 2000. There was a higher percentage of women as first authors (16% vs 2%) and last authors (10% vs 6%) in more recently published articles than in the overall top 50. Most articles contained level IV evidence (66% and 50%) (Table 3). Only 6% of authors overall had been cited on the OITE in the past 5 years.

The Mayo Clinic produced the most articles on the all-time list (*n* = 14), whereas the American Sports Medicine Institute published the most articles since 2000 (*n* = 7). Table 4 displays the three journals with the most publications in the overall top 50 and the 2000s. *Journal of Bone and Joint Surgery (Am)*, *American Journal of Sports Medicine*, and *Clinical Orthopaedics, and Related Research* appeared most frequently. There was no correlation between the overall number of citations and five-year journal impact (*r* = 0.051, *P* =.72) in the top 50 journals published overall, but there was a weak positive correlation between the number of citations and journal impact factor (*r* = 0.312, *P* =.03) in those articles published since 2000. There was no correlation between the number of citations and the overall level of evidence or articles published since

Table 1
List of the Top 50 Most Frequently Cited Articles Related to Elbow Surgery

	Article Title	First Author	Institution of Lead Author	Journal Title	Times Cited	Citation Density
1	Kinetics of baseball pitching with implications about injury mechanisms	Glenn S Fleisig	American Sports Medicine Institute	AJSM	841	31
2	A biomechanical study of normal functional elbow motion	Bernard Morrey	Mayo Clinic	JBJS	735	18
3	Some observations on fractures of the head of the radius with a review of 100 cases	Mark L Mason	Kent, Caterbury	BJS	567	8
4	Results of delayed excision of the radial head after fracture	Bernard Morrey	Mayo Clinic	JBJS	543	15
5	Treatment of chronic elbow tendinosis with buffered platelet-rich plasma	Allan Mishra	Stanford University	AJSM	540	34
6	Articular and ligamentous contributions to the stability of the elbow joint	Bernard Morrey	Mayo Clinic	AJSM	538	14
7	Valgus stability of the elbow—a definition of primary and secondary constraints	Bernard Morrey	Mayo Clinic	CORR	509	16
8	Posterolateral rotatory instability of the elbow	Shawn O'Driscoll	St. Michael's Hospital	JBJS	482	16
9	Tennis elbow-surgical treatment of lateral epicondylitis	Robert P Nirschl	Virginia Hospital	JBJS	477	11
10	Blind pinning of displaced supracondylar fractures of humerus in children-16 years experience with long-term follow-up	Joseph Flynn	Orange Memorial Hospital	JBJS	439	9
11	Reconstruction of the ulnar collateral ligament in athletes	Frank W Jobe	Kerlan-Jobe Orthopaedic Clinic	JBJS	435	12
12	Positive effect of an autologous platelet concentrate in lateral epicondylitis in a double-blind, randomized controlled trial: platelet-rich plasma versus corticosteroid injection with a 1-year follow-up	Joost Peerbooms	HAGA Hospital	AJSM	431	36
13	Effect of pitch type, pitch count, and pitching mechanics on risk of elbow and shoulder pain in youth baseball pitchers	Stephen Lyman	American Sports Medicine Institute	AJSM	429	21
14	Tendinosis of the elbow (tennis elbow)-clinical features and findings of histological, immunohistochemical, and electron microscopy studies	Barry Kraushaar	Orthopaedic and Sports Medicine Associates	JBJS	428	19
15	Medial instability of the elbow in throwing athletes-treatment by repair or reconstruction of the ulnar collateral ligament	John E Conway	Kerlan-Jobe Orthopaedic Clinic	JBJS	415	14
16	Fractures of the coronoid process of the ulna	William Regan	Mayo Clinic	JBJS	407	12
17	Risk factors for shoulder and elbow injuries in adolescent baseball pitchers	Samuel Olsen II	American Sports Medicine Institute	AJSM	399	25
18	Prevalence and projections of total shoulder and elbow arthroplasty in the United States to 2015	Judd Day	Biomechanics Practice, Exponent Inc	JSES	376	31
19	Results of treatment of fracture-dislocations of the elbow	Mark Broberg	Mayo Clinic	CORR	373	11
20	Semiconstrained arthroplasty for the treatment of rheumatoid arthritis of the elbow	Bernard Morrey	Mayo Clinic	JBJS	358	12
21	Rupture of the distal tendon of the biceps brachii—a biomechanical study	Bernard Morrey	Mayo Clinic	JBJS	336	9
22	Longitudinal study of elbow and shoulder pain in youth baseball pitchers	Stephen Lyman	American Sports Medicine Institute	MSSE	334	16
23	Ongoing positive effect of platelet-rich plasma versus corticosteroid injection in lateral epicondylitis: a double-blind randomized controlled trial with 2-year follow-up	Taco Gosens	St. Elisabeth Hospital	AJSM	317	29
24	Elbow subluxation and dislocation—a spectrum of instability	Shawn O'Driscoll	Mayo Clinic	CORR	300	10
25	Elbow tendinosis/tennis elbow	Robert P Nirschl	Virginia Sports Medicine Institute	CSM	299	10
26	Posterior dislocation of the elbow with fractures of the radial head and coronoid	David Ring	Massachusetts General Hospital	JBJS	297	15
27	Rupture of the distal tendon of the biceps brachii-operative treatment versus non-operative treatment	Bruce E Baker	Crouse Hospital	JBJS	289	8
28	Outcome of ulnar collateral ligament reconstruction of the elbow in 1281 athletes: results in 743 athletes with minimum 2-year follow-up	E Lyle Cain Jr.	American Sports Medicine Institute	AJSM	274	23
29	Management of displaced extension-type supracondylar fractures of the humerus in children	Arthur Pirone	Hospital for Sick Children	JBJS	273	6
30	Review of treatment results for ulnar nerve entrapment at the elbow	A Lee Dellon	Johns Hopkins University School of Medicine	JHS	273	8
31	Tennis elbow-its course, natural-history, conservative and surgical management	Ralph Coonrad	Duke University	JBJS	273	8
32	Biomechanical study of ligaments around the elbow joint	William Regan	Mayo Clinic	CORR	270	9
33	Biomechanics of the elbow during baseball pitching	Sherry Werner	Penn State University	JOSPT	270	9
34	Operative treatment of ulnar collateral ligament injuries of the elbow in athletes	Frederick Azar	American Sports Medicine Institute	AJSM	269	12
35	Supracondylar humeral fractures in children	Reza Omid	Children's Hospital Los Angeles	JBJS	265	19
36	Posttraumatic contracture of the elbow-operative treatment, including distraction arthroplasty	Bernard Morrey	Mayo Clinic	JBJS	263	8
37	Functional anatomy of the ligaments of the elbow	Bernard Morrey	Mayo Clinic	CORR	259	7
38	Open reduction and internal fixation of fractures of the radial head	David Ring	Massachusetts General Hospital	JBJS	257	13

Table 1 (continued)

	Article Title	First Author	Institution of Lead Author	Journal Title	Times Cited	Citation Density
39	Changes in indicators of inflammation after eccentric exercise of the elbow flexors	Kazunori Nosaka	Yokohama City University	MSSE	256	10
40	The Coonrad-Morrey total elbow arthroplasty in patients who have rheumatoid arthritis. A ten to fifteen-year follow-up study	David Gill	Mayo Clinic	JBJS	254	11
41	Elbow injuries in throwing athletes: A current concepts review	E Lyle Cain Jr.	American Sports Medicine Institute	AJSM	253	13
42	Standard surgical protocol to treat elbow dislocations with radial head and coronoid fractures	David Pugh	St. Michael's Hospital	JBJS	253	14
43	Distal biceps tendon ruptures: incidence, demographics, and the effect of smoking	Marc Safran	University of California	CORR	247	12
44	A method for reinsertion of the distal biceps brachii tendon	H Boyd	Campbell Foundation	JBJS	246	4
45	Medial collateral ligament reconstruction of the elbow using the docking technique	Joel Rohrbough	Hospital for Special Surgery	AJSM	241	12
46	Biomechanical evaluation of the medial collateral ligament of the elbow	George Hadley Callaway	Hospital for Special Surgery	JBJS	238	10
47	Electrophysiological findings in the entrapment of median nerve at wrist and elbow	Fritz Buchthal	University of Copenhagen	JNNP	236	6
48	Intercondylar fractures of the humerus-an operative approach	Jesse Jupiter	Massachusetts General Hospital	JBJS	236	5
49	Ulnar collateral ligament reconstruction in high school baseball players: clinical results and injury risk factors	Damon Petty	American Sports Medicine Institute	AJSM	235	13
50	Total elbow arthroplasty as primary treatment for distal humeral fractures in elderly patients	Tyson Cobb	Mayo Clinic	JBJS	234	9

AJSM, American Journal of Sports Medicine; CORR, Clinical Orthopaedics and Related Research; JBJS, Journal of Bone and Joint Surgery; JHS, Journal of Hand Surgery; JNNP, Journal of Neurology, Neurosurgery and Psychiatry; JSES, Journal of Shoulder and Elbow Surgery; MSSE, Medicine and Science in Sports and Exercise.

2000 ($r = -0.17$, $P = .91$; $r = 0.117$, $P = .42$). There was also no correlation between overall citation density or citation density in articles published since 2000 with the level of evidence ($r = -0.026$, $P = .86$; $r = -0.271$, $P = .06$).

Discussion

“Fracture” was the most common topic for the top 50 most-cited articles pertaining to elbow surgery. Huo et al¹⁰ found similar results for articles published from 1950 to 2010. This likely reflects the wide range of orthopedic subspecialties that manage skeletal injuries involving the distal humerus and proximal forearm.

However, when examining the top 50 most-cited articles published since 2000 only, lateral epicondylitis was found as frequently as articles related to fracture. This likely reflects changes in the management of lateral epicondylitis in recent years and controversies regarding optimal management.

Many studies have been published over the 2000s comparing various treatment options with no major consensus on the optimal strategy.^{36–38} In addition, there has been a greater focus on mental and psychological factors relating to lateral elbow pain.³⁹ When looking more deeply at the articles included in the top 50 groups, the scope of lateral epicondylitis studies has shown a similar shift. For example, many of the older articles in the overall top 50 group related to lateral epicondylitis have primarily focused on the natural history of the disease with broad discussions of nonsurgical and surgical treatments. However, at the beginning of the 2000s, more articles were clinical trials focused on comparisons between nonsurgical interventions.

For the overall top 50 most-cited articles and those published since 2000, levels of evidence were low, with retrospective case series (level IV evidence) occurring most frequently. The percentage of articles containing level IV evidence decreased when comparing the 21st-century list to the overall top 50 group. Level IV evidence has been found to be the most common level of evidence noted in similar studies performed in other orthopedic subspecialties, including shoulder, trauma, spine, and adult reconstruction.^{11,13,15,17} A bibliometric analysis of the top articles

in plastic surgery also found level IV evidence to be the most common (68%).⁴⁰ Previous studies in other disciplines of medicine and surgery have not previously quantified levels of evidence for these most-cited articles, which prevents comparisons to our results.^{2,41–46} Before 2000, only 2.9% of studies published in *The Journal of Bone and Joint Surgery* qualified as randomized trials.⁴⁷ This number increased to 21% in the same journal by 2005.⁴⁸ Still, the AAOS and Orthopaedic Research Society have made it a priority to increase the number of randomized controlled trials (RCTs) and other higher-level studies in orthopedic research.^{49–52} Since 2005, studies have continued to show an increased number of RCTs in the field of orthopedics.^{53,54} Despite this increase in RCTs published over time, the most-cited articles continue to contain overall low levels of evidence.

In the bibliometric analysis of the overall 50 most-cited articles in elbow surgery and from the 2000s, only 8% of the overall top 50 group included a female first and/or last author. This improved to 24% for articles published after 2000. Hiller et al⁵⁵ recently examined publishing rates in three of the most prominent orthopedic journals by sex from 2006 to 2017 and found that only 800 (13%) of 6,292 articles were first authored by women, and 604 (10%) were last authored by women. When comparing female first authorship rates among subspecialties, they found the hand to have approximately a 15% incidence, which is similar to the findings we found for the top 50 elbow articles of the 2000s.⁵⁵ Similarly, Johnson et al⁵⁶ recently performed a study of sex disparity within published pediatric orthopedic research, finding lower publication rates in projects with female last authors versus male last authors. In the context of other recent investigations related to authorship sex in hand surgery, our results suggest that although female authors remain underrepresented, there appears to be an increasing trend in female authorship, including high-impact academic publications.

The AAOS has made it a priority to increase the recruitment of female candidates into orthopedics due to the continued underrepresentation of female hand surgeons.^{57,58} As recently as 2016, women comprised 6.5% of hand surgeons belonging to the AAOS and 15% of orthopedic residents.^{59,60} Several other recent studies have shown sex inequity in publishing and leadership roles in both

Table 2
Top Fifty Articles in Elbow Surgery Since 2000

	Article Title	First Author	Institution of Lead Author	Source Title	Times Cited	Citation Density
1	Treatment of chronic elbow tendinosis with buffered platelet-rich plasma	Allan Mishra	Stanford University	AJSM	540	34
2	Positive effect of an autologous platelet concentrate in lateral epicondylitis in a double-blind randomized controlled trial: platelet-rich plasma versus corticosteroid injection with a 1-year follow-up	Joost Peerbooms	HAGA Hospital	AJSM	431	36
3	Effect of pitch type, pitch count, and pitching mechanics on risk of elbow and shoulder pain in youth baseball pitchers	Stephen Lyman	American Sports Medicine Institute	AJSM	429	21
4	Risk factors for shoulder and elbow injuries in adolescent baseball pitchers	Samuel Olsen	American Sports Medicine Institute	AJSM	399	25
5	Prevalence and projections of total shoulder and elbow arthroplasty in the United States to 2015	Judd Day	Drexel University	JSES	376	31
6	Longitudinal study of elbow and shoulder pain in youth baseball pitchers	Stephen Lyman	American Sports Medicine, Alabama	MSSE	334	16
7	Ongoing positive effect of platelet-rich plasma versus corticosteroid injection in lateral epicondylitis: a double-blind randomized controlled trial with 2-year follow-up	Taco Gosens	St Elisabeth Hospital	AJSM	317	29
8	Posterior dislocation of the elbow with fractures of the radial head and coronoid	David Ring	Massachusetts General Hospital	JBJS	297	15
9	Outcome of ulnar collateral ligament reconstruction of the elbow in 1281 athletes: results in 743 athletes with minimum 2-year follow-up	E Lyle Cain	American Sports Medicine Institute	AJSM	274	23
10	Operative treatment of ulnar collateral ligament injuries of the elbow in athletes	Frederick Azar	American Sports Medicine Institute	AJSM	269	12
11	Supracondylar humeral fractures in children	Reza Omid	Children's Hospital Los Angeles	JBJS	265	19
12	Open reduction and internal fixation of fractures of the radial head	David Ring	Massachusetts General Hospital	JBJS	257	13
13	Elbow injuries in throwing athletes: a current concepts review	Edwards Cain	American Sports Medicine Institute	AJSM	253	14
14	Standard surgical protocol to treat elbow dislocations with radial head and coronoid fractures	David Pugh	St Michael's Hospital	JBJS	253	13
15	Distal biceps tendon ruptures: incidence, demographics, and the effect of smoking	Marc Safran	University of California San Francisco	CORR	247	12
16	Medial collateral ligament reconstruction of the elbow using the docking technique	Joel Rohrbough	Hospital for Special Surgery	AJSM	241	12
17	Ulnar collateral ligament reconstruction in high school baseball players: clinical results and injury risk factors	Damon Petty	American Sports Medicine Institute	AJSM	235	13
18	Operative treatment of supracondylar fractures of the humerus in children. The consequences of pin placement	David Skaggs	Children's Hospital Los Angeles	JBJS	230	11
19	Results of nerve transfer techniques for restoration of shoulder and elbow function in the context of a meta-analysis of the English literature	Gregory Merrell	Yale	JHS	228	11
20	A multicenter, prospective, randomized, controlled trial of open reduction-internal fixation versus total elbow arthroplasty for displaced intra-articular distal humeral fractures in elderly patients	Michael McKee	St. Michael's Hospital	JSES	227	17
21	Complications of elbow arthroscopy	Edward Kelly	Mayo Clinic	JBJS	225	11
22	Arthroplasty with a metal radial head for unreconstructible fractures of the radial head	Jaydeep Moro	St. Joseph's/McMaster University	JBJS	219	10
23	Adult distal humeral metaphyseal fractures: epidemiology and results of treatment	Michael Robinson	Royal Infirmary of Edinburgh	JOT	215	11
24	A systematic review and meta-analysis of clinical trials on physical interventions for lateral epicondylalgia	Leanne Bisset	University of Queensland	BJSM	213	13
25	Platelet-rich plasma versus autologous whole blood for the treatment of chronic lateral elbow epicondylitis a randomized controlled clinical trial	Christos Thanasis	Henry Dunant Hospital	AJSM	208	19
26	Efficacy of platelet-rich plasma for chronic tennis elbow a double-blind, prospective, multicenter, randomized controlled trial of 230 patients	Allan Mishra	Stanford University	AJSM	206	26
27	Coronoid process and radial head as posterolateral rotatory stabilizers of the elbow	Alberto Schneeberger	University of Zurich	JBJS	203	11
28	Rate of return to pitching and performance after Tommy John surgery in major league baseball pitchers	Brandon Erickson	Rush University	AJSM	201	25
29	Ulnar collateral ligament reconstruction in athletes: muscle-splitting approach without transposition of the ulnar nerve	William Thompson	Florida Orthopaedic Institute	JSES	199	9
30	Changes in inflammatory mediators following eccentric exercise of the elbow flexors	Lisa Hirose	Waseda University	EIR	198	11
31	Treatment of lateral epicondylitis with platelet-rich plasma, glucocorticoid, or saline a randomized, double-blind, placebo-controlled trial	Thoger Persson Krogh	Region Hospital Silkeborg	AJSM	197	22
32	Shoulder range of motion measures as risk factors for shoulder and elbow injuries in high school softball and baseball players	Ellen Shanley	Orthopedic Research Foundation of the Carolinas	AJSM	196	18
33	Complications of repair of the distal biceps tendon with the modified two-incision technique	Edward Kelly	Mayo Clinic	JBJS	193	9
34	A comparison of open reduction and internal fixation and primary total elbow arthroplasty in the treatment of intraarticular distal humerus fractures in women older than age 65	Mark Frankle	Florida Orthopaedic Institute	JOT	191	10
35	Autologous blood injections for refractory lateral epicondylitis	Scott Edwards	University of Tennessee/Campbell Clinic	JHS	187	10
36	Elevations in ostensibly anabolic hormones with resistance exercise enhance neither training-induced muscle hypertrophy nor strength of the elbow flexors	Daniel West	McMaster University	JAPPL	183	15

Table 2 (continued)

	Article Title	First Author	Institution of Lead Author	Source Title	Times Cited	Citation Density
37	Repair of distal biceps tendon rupture: A new technique using the Endobutton	Gregory Bain	University of Adelaide	JSES	180	8
38	Supraspinal fatigue during intermittent maximal voluntary contractions of the human elbow flexors	Janet Taylor	Prince of Wales Medical Research Institute	JAPPL	178	8
39	Growth factor-based therapies provide additional benefit beyond physical therapy in resistant elbow tendinopathy: a prospective, single-blind, randomised trial of autologous blood injections versus platelet-rich plasma injections	Leon Creaney	BUPA Health and Wellbeing	BJSM	175	16
40	Comminuted radial head fractures treated with a modular metallic radial head arthroplasty. Study of outcomes	Ruby Grewal	University of Western Ontario	JBJS	173	11
41	Classification, treatment, and outcome of osteochondritis dissecans of the humeral capitellum	Masatoshi Takahara	Yamagata University	JBJS	172	11
42	Results of reinnervation of the biceps and brachialis muscles with a double fascicular transfer for elbow flexion	Susan Mackinnon	Washington University	JHS	165	10
43	Displaced pediatric supracondylar humerus fractures: biomechanical analysis of percutaneous pinning techniques	Steven Lee	Children's Hospital San Diego	JPO	164	8
44	Lateral-entry pin fixation in the management of supracondylar fractures in children	David Skaggs	Children's Hospital Los Angeles	JBJS	163	9
45	Ligamentous stabilizers against posterolateral rotatory instability of the elbow	Cynthia Dunning	University of Western Ontario	JBJS	162	8
46	The role of the coronoid process in elbow stability	Robert Closky	Robert Wood Johnson University Hospital	JBJS	161	7
47	Functional outcome following surgical treatment of intra-articular distal humeral fractures through a posterior approach	Michael McKee	St Michael's Hospital	JBJS	160	7
48	The effect of radial head excision and arthroplasty on elbow kinematics and stability	Daphne Beigessner	Harborview Medical Center	JBJS	159	9
49	Correlation of throwing mechanics with elbow valgus load in adult baseball pitchers	Arnel Aguinaldo	Rady Children's Hospital	AJSM	158	9
50	Prospective randomized controlled study comparing simple decompression versus anterior subcutaneous transposition for idiopathic neuropathy of the ulnar nerve at the elbow: Part 1	Ronald H M A Bartels	Radboud University Nijmegen Medical Center	NJ	158	12

AJSM, American Journal of Sports Medicine; BJSM, British Journal of Sports Medicine; CORR, Clinical Orthopaedics, and Related Research; EIR, Exercise Immunology Review; JAPPL, Journal of Applied Physiology; JBJS, Journal of Bone and Joint Surgery; JHS, Journal of Hand Surgery; JOT, Journal of Orthopaedic Trauma; JPO, Journal of Pediatric Orthopaedics; JSES, Journal of Shoulder and Elbow Surgery; MSSE, Medicine and Science in Sports and Exercise; NJ, Neurosurgery.

Table 3
Article Demographics for the 50 Most Frequently Cited Elbow Surgery Publications

	Top 50 (all yrs), n (%) [*]	Top 50 (2000–2022), n (%) [*]	P value
Country of first author			.09
United States	40 (80)	30 (60)	
Canada	4 (8)	7 (14)	
Other	6 (12)	13 (26)	
Language, English	50 (100)	50 (100)	—
Total citations, mean	355.38 (±133.31)	233.28 (±81.73)	<.05
Citation density, mean (±SD)	14.06 (±7.54)	14.84 (±7.17)	.60
Article topic			.30
Lateral epicondylitis	7 (14)	9 (18)	
Biomechanics	7 (14)	1 (2)	
Ligamentous reconstruction	5 (10)	6 (12)	
Fracture	10 (20)	9 (18)	
Distal biceps	3 (6)	3 (6)	
Instability/stiffness	3 (6)	2 (4)	
Cubital tunnel	2 (4)	1 (2)	
Arthroplasty	3 (6)	2 (6)	
More than one	6 (12)	7 (14)	
Other	4 (8)	11 (22)	
Level of evidence			.08
I	2 (4)	9 (18)	
II	1 (2)	3 (6)	
III	5 (10)	9 (18)	
IV	33 (66)	25 (50)	
V	6 (12)	2 (4)	
Other/cadaver	3 (6)	2 (4)	
Article type			>.99
Clinical	47 (94)	46 (92)	
Basic science	3 (6)	4 (8)	
First author sex, female	1 (2)	8 (16)	<.05
Last author sex, female	3 (6)	5 (10)	.10
Any female author	4 (8)	12 (24)	.05
Number of articles included in OITE within last 5 yrs	3 (6)	4 (8)	>.99

^{*}Unless specified otherwise.

Table 4
Journals Publishing the Top 50 Elbow Articles Overall and Since 2000

Journal of Publication, (n, 5-year impact)	
All Yrs	2000–2022
Journal of Bone and Joint Surgery, American Volume (24, 3.851)	Journal of Bone and Joint Surgery, American Volume (16, 3.851)
American Journal of Sports Medicine (12, 5.435)	American Journal of Sports Medicine (16, 5.435)
Clinical Orthopaedics and Related Research (6, 1.735)	Journal of Shoulder and Elbow Surgery (4, 3.262)

In parenthesis, first number indicates number of articles from respective journal; second number indicates journal impact factor.

hand/upper-extremity surgery and other fields of orthopedics.^{55,56,61} Brisbin et al⁶¹ recently published a cross-sectional study of the leadership positions in the American Society for Surgery of the Hand and the American Association for Hand Surgery, as well as directors of the Hand Surgery Fellowship Program and physician lead editors of peer-reviewed hand journals. They found that only 29 (13.6%) of 213 of these leadership positions are held by women, which is disproportionately small compared to the number of female hand surgery fellows (25.7% at time of data collection).^{61,62}

In reviewing the cited articles on the OITE reference list, 8% of the top 50 elbow articles published since 2000 were cited in the exam. Three of those cited in OITE answers from the overall top 50 group were published in the 2000s, including Lyman et al, Cain et al, and Pugh et al.^{63–65} To the authors' knowledge, this is the first bibliometric analysis that assessed the relationship between the top 50 cited articles and citations on the OITE. Given the overall low inclusion of these top 50 articles on the OITE, review of these articles alone would likely not be sufficient preparation for the exam. It is possible that these results are skewed from the top 50 articles because of other factors; the average time between publication and reference on the OITE is approximately 8 years, with 46% of articles cited published within 5 years of appearing on the test.^{29,30} Articles on both top-50 lists may provide valuable insight for orthopedic trainees but remain infrequently tested.

There are several limitations to this study, many of which are inherent to bibliometric analyses.¹¹ Articles were screened through the Web of Science search function, which may have unintentionally excluded relevant articles. It is possible that our search results may have been biased by the search terms used. For example, using search terms that were primarily the bones around the elbow may have skewed our results to bony topics, such as fractures. A top 50 article does not necessarily reflect the best literature quality or level of evidence. In fact, most of the studies are of lower levels of evidence, as it is difficult to conduct higher-level clinical studies for many topics. Absolute citation number and citation density may have been biased to certain topics, individuals, and institutions. For example, lateral epicondylitis has been the most published topic, but this is not representative of the most important topic in elbow surgery. Similarly, the Mayo Clinic was the institution responsible for the most published articles in elbow surgery, owing to its long-standing research in the field of elbow surgery with several well-known names in the field. However, this does not necessarily mean that research from the Mayo Clinic is of better quality than other institutions. Similarly, there are limitations to assessing the quality of a journal's material for several reasons, including using a journal's impact factor. The impact factor was initially derived only to compare citation rates between journals. Therefore, it cannot accurately comment on the quality of research in those journals, nor can it be used to compare journals of different subspecialties.⁶⁶

Small available sample sizes for the top 50 groups limited proper statistical comparisons, which would have been underpowered. Finally, we were also limited by determining the author's sex through the availability of online photos alone.

In conclusion, we analyzed the top 50 most frequently cited articles on elbow surgery, both overall and those published in the 21st century. The most frequently cited elbow surgery articles are related to fracture care about the elbow and, more recently, lateral epicondylitis. Overall, the most frequently cited articles contain lower levels of evidence, with RCTs found infrequently. Women were underrepresented as authors for articles featured on these lists; however, there appears to be a recent trend toward increasing female authorship. With the recent increase in publications, recognizing impactful articles in the field of elbow surgery may create a "modern reading list" and direct surgeons toward articles, authors, and institutions that help define contemporary elbow surgery practices.

References

- Jiang Y, Hu R, Zhu G. Top 100 cited articles on infection in orthopaedics: a bibliometric analysis. *Medicine*. 2019;98(2):e14067.
- Pagni M, Khan NR, Cohen HL, Choudhri AF. Highly cited works in radiology: the top 100 cited articles in radiologic journals. *Acad Radiol*. 2014;21(8):1056–1066.
- Soteriades ES, Falagas ME. A bibliometric analysis in the fields of preventive medicine, occupational and environmental medicine, epidemiology, and public health. *BMC Public Health*. 2006;6:301.
- Mavrogenis AF, Megaloikonomos PD, Panagopoulos GN, Mauffrey C, Quaille A, Scarlat MM. Best one hundred papers of international orthopaedics: a bibliometric analysis. *Int Orthop*. 2017;41(4):689–697.
- Kelly JC, Glynn RW, O'Briain DE, Felle P, McCabe JP. The 100 classic papers of orthopaedic surgery: a bibliometric analysis. *J Bone Joint Surg Br*. 2010;92(10):1338–1343.
- Lefavre KA, Shadgan B, O'Brien PJ. 100 most cited articles in orthopaedic surgery. *Clin Orthop Relat Res*. 2011;469(5):1487–1497.
- Vielgut I, Dauwe J, Leithner A, Holzer LA. The fifty highest cited papers in anterior cruciate ligament injury. *Int Orthop*. 2017;41(7):1405–1412.
- Malik AT, Noordin S. The top 50 most-cited articles on total ankle arthroplasty: a bibliometric analysis. *Orthop Rev (Pavia)*. 2018;10(1):7498.
- Piolanti N, Poggetti A, Nucci AM, et al. The 50 most cited articles about wrist surgery. *Orthop Rev (Pavia)*. 2018;10(4):7715.
- Huo YQ, Pan XH, Li QB, et al. Fifty top-cited classic papers in orthopedic elbow surgery: a bibliometric analysis. *Int J Surg*. 2015;18:28–33.
- Namdari S, Baldwin K, Kovatch K, Huffman GR, Glaser D. Fifty most cited articles in orthopedic shoulder surgery. *J Shoulder Elbow Surg*. 2012;21(12):1796–1802.
- Kavanagh RG, Kelly JC, Kelly PM, Moore DP. The 100 classic papers of pediatric orthopaedic surgery: a bibliometric analysis. *J Bone Joint Surg Am*. 2013;95(18):e134.
- Baldwin K, Namdari S, Donegan D, Kovatch K, Ahn J, Mehta S. 100 most cited articles in fracture surgery. *Am J Orthop (Belle Mead NJ)*. 2013;42(12):547–552.
- Bayley M, Brooks F, Tong A, Hariharan K. The 100 most cited papers in foot and ankle surgery. *Foot (Edinb)*. 2014;24(1):11–16.
- Murray MR, Wang T, Schroeder GD, Hsu WK. The 100 most cited spine articles. *Eur Spine J*. 2012;21(10):2059–2069.
- Joyce CW, Kelly JC, Carroll SM. The 100 top-cited classic papers in hand surgery. *J Plast Surg Hand Surg*. 2014;48(4):227–233.
- Holzer LA, Holzer G. The 50 highest cited papers in hip and knee arthroplasty. *J Arthroplasty*. 2014;29(3):453–457.
- Cassar Gheiti AJ, Downey RE, Byrne DP, Molony DC, Mulhall KJ. The 25 most cited articles in arthroscopic orthopaedic surgery. *Arthroscopy*. 2012;28(4):548–564.
- National Science Foundation. Publication Output: US Trends and International Comparisons. Accessed June 19, 2022. <https://nces.nsf.gov/pubs/nsb20206/publication-output-by-region-country-or-economy#msclid=84930627cf2b17eca3e47831121ac1f9>
- Van Heest AE, Agel J, Samora JB. A 15-year report on the uneven distribution of women in orthopaedic surgery residency training programs in the United States. *JB JS Open Access*. 2021;6(2):e20.00157.
- Peters AW, Savaglio MK, Gunderson ZJ, et al. Comparative analysis of authorship trends in the journal of hand surgery European and American volumes: a bibliometric analysis. *Ann Med Surg (Lond)*. 2020;55:200–206. <https://doi.org/10.1016/j.amsu.2020.05.015>
- Prior A, Ogburu-Ogbonnaya N, Barfield WR, Mooney JF III, Van Nortwick S, Murphy RF. Analysis of author gender in the pediatric orthopaedic literature from 2011 to 2020. *J Pediatr Orthop*. 2021;41(7):e481–e483.
- Xu RF, Varady NH, Chen AF. Trends in gender disparities in authorship of arthroplasty research. *J Bone Joint Surg Am*. 2020;102(23):e131.

24. Brown MA, Erdman MK, Munger AM, Miller AN. Despite growing number of women surgeons, authorship gender disparity in orthopaedic literature persists over 30 years. *Clin Orthop Relat Res.* 2020;478(7):1542–1552.
25. Buckwalter JA, Schumacher R, Albright JP, Cooper RR. The validity of orthopaedic in-training examination scores. *J Bone Joint Surg Am.* 1981;63(6):1001–1006.
26. Swanson D, Marsh JL, Hurwitz S, et al. Utility of AAOS OITE scores in predicting ABOS part I outcomes: AAOS exhibit selection. *J Bone Joint Surg Am.* 2013;95(12):e84.
27. Fritz E, Bednar M, Harrast J, et al. Do orthopaedic in-training examination scores predict the likelihood of passing the American Board of Orthopaedic Surgery Part I Examination? An update with 2014 to 2018 data. *J Am Acad Orthop Surg.* 2021;29(24):e1370–e1377.
28. Knowledge ABOS, Skills, and Behavior Program. Accessed June 19, 2022. https://www.abos.org/wp-content/uploads/2021/06/ABOS_ResidentDirector_Handbook_V2_062321.pdf
29. Stone NE III, Kang KK, Eiseimon EO, Choueka J. The most-cited sources on the orthopaedic in-training examination: question yield, reading efficiency, and time lag from publication. *Bull Hosp Jt Dis (2013).* 2013;71(4):245–252.
30. Haughom BD, Goldstein Z, Hellman MD, Yi PH, Frank RM, Levine BR. An analysis of references used for the orthopaedic in-training examination: what are their levels of evidence and journal impact factors? *Clin Orthop Relat Res.* 2014;472(12):4024–4032.
31. Le HV, Wick JB, Haus BM, Dyer GSM. Orthopaedic in-training examination: history, perspective, and tips for residents. *J Am Acad Orthop Surg.* 2021;29(9):e427–e437.
32. Grandizio LC, Huston JC, Shim SS, Graham J, Klena JC. Levels of evidence for hand questions on the orthopaedic in-training examination. *Hand (N Y).* 2016;11(4):484–488.
33. Walsh CT, Grandizio LC, Klena JC, Parenti JM, Cush GJ. Levels of evidence for foot and ankle questions on the orthopaedic in-training examination: 15-year trends. *J Surg Educ.* 2016;73(6):999–1003.
34. Grandizio LC, Huston JC, Shim SS, Parenti JM, Graham J, Klena JC. Levels of evidence have increased for musculoskeletal trauma questions on the orthopaedic in-training examination. *J Surg Educ.* 2015;72(2):258–263.
35. Okike K, Liu B, Lin YB, et al. The orthopedic gender gap: trends in authorship and editorial board representation over the past 4 decades. *Am J Orthop (Belle Mead NJ).* 2012;41(7):304–310.
36. Smidt N, van der Windt DA, Assendelft WJ, Devillé WL, Korthals-de Bos IB, Bouter LM. Corticosteroid injections, physiotherapy, or a wait-and-see policy for lateral epicondylitis: a randomised controlled trial. *Lancet.* 2002;359(9307):657–662.
37. Bisset L, Beller E, Jull G, Brooks P, Darnell R, Vicenzino B. Mobilisation with movement and exercise, corticosteroid injection, or wait and see for tennis elbow: randomised trial. *BMJ.* 2006;333(7575):939.
38. Garg R, Adamson GJ, Dawson PA, Shankwiler JA, Pink MM. A prospective randomized study comparing a forearm strap brace versus a wrist splint for the treatment of lateral epicondylitis. *J Shoulder Elbow Surg.* 2010;19(4):508–512.
39. Aben A, De Wilde L, Hollevoet N, et al. Tennis elbow: associated psychological factors. *J Shoulder Elbow Surg.* 2018;27(3):387–392.
40. Loonen MPJ, Hage JJ, Kon M. Plastic surgery classics: characteristics of 50 top-cited articles in four plastic surgery journals since 1946. *Plast Reconstr Surg.* 2008;121(5):320e–327e.
41. Tas F. An analysis of the most-cited research papers on oncology: which journals have they been published in? *Tumour Biol.* 2014;35(5):4645–4649.
42. Tam WW, Wong EL, Wong FC, Hui DS. Citation classics: top 50 cited articles in “respiratory system”. *Respirology.* 2013;18(1):71–81.
43. Nason CJ, Tareen F, Mortell A. The top 100 cited articles in urology: an update. *Can Urol Assoc J.* 2013;7(1–2):E16–E24.
44. Baltussen A, Kindler CH. Citation classics in anesthetic journals. *Anesth Analg.* 2004;98(2):443–451.
45. Paladugu R, Schein M, Gardezi S, Wise L. One hundred citation classics in general surgical journals. *World J Surg.* 2002;26(9):1099–1105.
46. Tsai YL, Lee CC, Chen SC, Yen ZS. Top-cited articles in emergency medicine. *Am J Emerg Med.* 2006;24(6):647–654.
47. Bhandari M, Richards RR, Sprague S, Schemitsch EH. The quality of reporting of randomized trials in the journal of bone and joint surgery from 1988 through 2000. *J Bone Joint Surg Am.* 2002;84(3):388–396.
48. Trippel SB, Bosse MJ, Heck DA, Wright JG, Symposium. How to participate in orthopaedic randomized clinical trials. *J Bone Joint Surg Am.* 2007;89(8):1856–1864.
49. Bederman SS, Chundamala J, Wright JG. Randomized clinical trials in orthopaedic surgery: strategies to improve quantity and quality. *J Am Acad Orthop Surg.* 2010;18(8):454–463.
50. Wright JG, Katz JN, Losina E. Clinical trials in orthopaedics research. Part I. Cultural and practical barriers to randomized trials in orthopaedics. *J Bone Joint Surg Am.* 2011;93(5):e15.
51. Katz JN, Wright JG, Losina E. Clinical trials in orthopaedics research. Part II. Prioritization for randomized controlled clinical trials. *J Bone Joint Surg Am.* 2011;93(7):e30.
52. Losina E, Wright J, Katz JN. Clinical trials in orthopaedics research. Part III. Overcoming operational challenges in the design and conduct of randomized clinical trials in orthopaedic surgery. *J Bone Joint Surg Am.* 2012;94(6):e35.
53. Matar HE, Platt SR. Overview of randomised controlled trials in orthopaedic research: search for significant findings. *Eur J Orthop Surg Traumatol.* 2019;29(6):1163–1168.
54. Little Z, Newman S, Dodds A, Spicer D. Increase in quality and quantity of orthopaedic studies from 2002 to 2012. *J Orthop Surg (Hong Kong).* 2015;23(3):375–378.
55. Hiller KP, Boulous A, Tran MM, Cruz Al Jr. What are the rates and trends of women authors in three high-impact orthopaedic journals from 2006–2017? *Clin Orthop Relat Res.* 2020;478(7):1553–1560.
56. Johnson MA, Mulvey H, Parambath A, Anari JB, Wall LB, Shah AS. A gender gap in publishing? Understanding the glass ceiling in pediatric orthopaedic surgery. *J Pediatr Orthop.* 2021;41(7):e484–e488.
57. Blakemore LC, Hall JM, Biermann JS. Women in surgical residency training programs. *J Bone Joint Surg Am.* 2003;85(12):2477–2480.
58. Poon S, Kiridly D, Mutawakkil M, et al. Current trends in sex, race, and ethnic diversity in orthopaedic surgery residency. *J Am Acad Orthop Surg.* 2019;27(16):e725–e733.
59. Aschenbrener CA, Ast C, Kirch DG. Graduate medical education: its role in achieving a true medical education continuum. *Acad Med.* 2015;90(9):1203–1209.
60. American Association of Orthopaedic Surgeons Department of Research. Quality and Scientific Affairs. Orthopaedic Practice in the US 2016. Accessed June 19, 2022. <https://www.aaos.org/globalassets/quality-and-practice-resources/census/2016-census-final-public.pdf>
61. Brisbin AK, Chen W, Goldschmidt E, Smith BT, Bourne DA. Gender diversity in hand surgery leadership. *Hand (N Y).* Published online March 10, 2022.
62. Association of American Medical Colleges. ACGME Residents and Fellows by Sex and Specialty. Accessed June 19, 2022. <https://www.aamc.org/data-reports/workforce/interactive-data/acgme-residents-and-fellows-sex-and-specialty-2017>
63. Lyman S, Fleisig GS, Andrews JR, Osinski ED. Effect of pitch type, pitch count, and pitching mechanics on risk of elbow and shoulder pain in youth baseball pitchers. *Am J Sports Med.* 2002;30(4):463–468.
64. Cain EL, Andrews JR, Dugas JR, et al. Outcome of ulnar collateral ligament reconstruction of the elbow in 1281 athletes: Results in 743 athletes with minimum 2-year follow up. *Am J Sports Med.* 2010;38(12):2426–2634.
65. Pugh DMW, Wild LM, Schemitsch EH, King GJW, McKee MD. Standard surgical protocol to treat elbow dislocations with radial head and coronoid fractures. *J Bone Joint Surg Am.* 2004;86(6):1122–1130.
66. Kurmis AP. Understanding the limitations of the journal impact factor. *J Bone Joint Surg Am.* 2003;85(12):2449–2454.