High-impact articles in hand surgery

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Abstract

Background There have been few attempts to identify classic papers within the hand surgery literature. This study used citation analysis to identify and characterize the top 50 highly cited hand surgery articles published in six peer-reviewed journals.

Methods The 50 most highly cited hand surgery articles were identified in the Journal of Bone and Joint Surgery (JBJS) American, JBJS British, Plastic and Reconstructive Surgery, Journal of Hand Surgery (JHS) American, JHS British/European, and Hand. Articles were evaluated for citations per year, surgical/anatomical topic, and type of study. Clinical studies were further sub-categorized by level of evidence. The distribution of topics was compared with all indexed hand surgery articles. The educational relevance was assessed via comparison with lists of “classic” papers.

Results The most common subjects were distal radius fracture, carpal tunnel syndrome, and flexor tendon repair. There was moderate correlation between the distribution of these topics and all indexed hand surgery articles ($\rho=0.71$). There were 31 clinical studies, of which 16 were therapeutic, ten were prognostic, and five were diagnostic. These articles assessed the outcomes of an intervention, described an anatomical/functional observation, introduced an innovation, presented a discovery/classification, or validated a questionnaire. There were only three randomized trials. Using citations per year to control for the influence of time since publication, 36

articles were consistently highly cited. Twenty-three articles were on Stern’s Selected Readings in Hand Surgery, considered important in education.

Conclusions The top 50 highly cited articles in hand surgery reflect the most common clinical, scientific, and educational efforts of the field.

Keywords Classic papers · Citation analysis · Hand surgery · High impact

Introduction

The development of hand surgery and the education of hand surgeons in America in the twentieth century are commonly attributed to Sterling Bunnell, a general surgeon who developed a keen interest in surgery of the hand. His seminal article describing tendon repair in 1918 initiated focused interest in this field [1, 2]. Bunnell’s involvement in hand surgery greatly increased as a result of the Second World War, when US Army Surgeon General Norman Kirk recognized the need for specialized surgeons and coordinated care to treat the various extremity injuries seen in combat. As a result, a formal system of treating hand injuries was begun. Hand surgery became a more specific specialty in the 1940s with the development of regional hand centers, the formation of hand societies, and publication of the monograph: Surgery of the Hand [3].

Since that time clinical interest in surgery of the hand has increased dramatically. The body of literature germane to hand surgery blossomed between 1950 and 1990, when hand surgery moved from the exclusive treatment of extremity trauma to include more diverse care such as reconstruction for arthritis and microsurgical tissue transfer. The formation of hand societies, including the American Society

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for Surgery of the Hand (ASSH) in 1946 and the American Association for Hand Surgery (AAHS) in 1970 has led to the development of more formal practice guidelines, a rigorous training system, and focused research with dedicated scientific journals as well as added certification in hand surgery by the American Board of Orthopedic Surgery, American Board of Surgery, and American Board of Plastic Surgery. The literature has broadened in scope to include all facets of adult and pediatric hand surgery.

Few authors have endeavored to describe the “classic” papers in the hand surgery literature. In one article, 26 papers and chapters were identified within 13 clinical categories and selected based on the author’s opinion and experience [15]. Another grouping of seminal articles within the field is Stern’s “Selected Readings in Hand Surgery,” where approximately 500 articles were identified based on their educational value for residents and fellows [12].

Despite the large volume of publications and the aforementioned grouping of classic papers, there have been no studies identifying in an objective, scientific manner the manuscripts with the most impact from the dedicated hand, orthopedic, and plastic surgery journals. The goal of this study was to identify the 50 most cited articles in hand surgery and to identify and categorize the subject matter described within.

Materials and Methods

A literature search was performed to identify highly cited articles from the following six scientific, peer-reviewed journals from their inception to the present: (1) Journal of Bone and Joint Surgery (JBJS) American Volume, (2) Journal of Bone and Joint Surgery (JBJS) British Volume, (3) Plastic and Reconstructive Surgery (PRS), (4) Journal of Hand Surgery (JHS) American Volume, (5) Journal of Hand Surgery (JHS) British and European Volume, and (6) Hand.

A literature search was performed on January 1, 2010, via Thomson/Reuters Web of Knowledge to identify the most cited articles in each of the aforementioned journals, and the top articles were then cross-checked for accuracy of content with the Medline database. Along with basic information about an article (such as author, title, date of publication), the Thomson/Reuters search engine provides information about the number of times that a particular article has been cited by other articles.

To obtain this citation information, we entered the Thomson/Reuters Web of Knowledge search engine online. This allows for search by “publication name,” and we independently and serially input each of the six journals used for this manuscript. All published articles for a given journal were then identified; the list was then sorted by “times cited.” For the purpose of this study, we sorted articles from each journal by times cited, from highest to lowest.

The top 1,000 highly cited articles for each of the six journals were identified in the above manner and collected into a spreadsheet. For the journals that have a more broad focus than just hand surgery (Plastic and Reconstructive Surgery, JBJS American, JBJS British), the senior author reviewed each article, starting with the most highly cited, and then separated the top 50 that explicitly reported about hand surgery. For the hand surgery specific journals (JHS American, JHS British and European, Hand), the top 50 cited articles were chosen.

The top 50 highly cited articles for each of the six journals were then combined into one spreadsheet (total of $50 \times 6 = 300$ articles) and sorted by times cited. The top 50 of the combined articles were selected to be the subject of this study. Each of these articles was then cross-checked against the Medline database to check accuracy of content and applicability to hand surgery. If there were any discrepancies, the original article was checked and kept in the study if accurate, or discarded from the study if inaccurate.

The top 50 highly cited articles were then sorted by number of citations, both in absolute number and also stratified by citations per year. This was done to eliminate the bias associated with publication year as older articles have had more time for citation. These 50 articles were further classified by surgical/anatomic topic (distal radius fracture, carpal tunnel syndrome, flexor tendon repair, wrist kinematics, triangular fibrocartilage complex (TFCC), scaphoid fracture and management, wrist instability, and nerve repair/grafting), type of study (clinical or experimental—defined as human vs. non-human subjects), and study sub-type: anatomical/functional, discovery/classification, innovation, validation, or outcomes. Anatomical/functional refers to a study that investigated the structural or mechanical components of the hand (an example of this would be a study of the ligaments surrounding the carpometacarpal joint of the thumb). Discovery refers to a study that led to the identification of a physiologic or clinical principle (an example would be the discovery that pressures in the carpal tunnel are elevated in carpal tunnel syndrome). Innovation refers to studies in which a novel technique or idea is presented; i.e., a new drug or surgical technique. Validation refers to a study that validated a questionnaire or survey (i.e., validation of the DASH survey). All clinical studies were further sub-categorized by level of evidence [13] and whether they were therapeutic, prognostic, diagnostic, or economic in nature.

The distribution, by topic, of the 50 most highly cited hand surgery articles was compared to the distribution of all indexed publications (Medline search) of these same topics.

To obtain a thematic distribution for the 50 most highly cited articles, the number of articles identified per category was divided by 50 and a percentage obtained, i.e., (scaphoid articles/50) %. To obtain a comparative thematic distribution

Table 1 Fifty most highly cited articles in hand surgery

Fifty most highly cited articles in hand surgery As of January 1, 2010		Total citations	Citations per year
1	The Carpal Tunnel Syndrome—17 Years experience in diagnosis and treatment of 654 hands. Phalen GS. <i>J Bone Joint Surg Am.</i> 1966; 48(2):211–228	553	13.49
2	A self-administered questionnaire for the assessment of severity of symptoms and functional status in carpal tunnel syndrome. Levine DW, Simmons BP, Koris MJ et al. <i>J Bone Joint Surg Am.</i> 1993; 75(11):1585–92	429	30.64
3	The prehensile movements of the human hand. Napier JR. <i>J Bone Joint Surg Br.</i> 1956; 38(4):902–913	382	7.49
4	Evaluation of healed Colles fractures. Gartland JJ, Werley CW. <i>J Bone Joint Surg Am.</i> 1951; 33(4):895–907	353	6.30
5	Traumatic instability of the wrist—diagnosis, classification, and pathomechanics. Linscheid RL, Dobyns JH, Beabout JW et al. <i>J Bone Joint Surg Am.</i> 1972; 54(8):1612–1632.	351	10.03
6	Intra-articular fractures of the distal end of the radius in young adults. Knirk JL, Jupiter JB. <i>J Bone Joint Surg Am.</i> 1986; 68(5):647–659	342	16.29
7	Reliability and validity of grip and pinch strength evaluations. Mathiowetz V, Weber K, Volland G et al. <i>J Hand Surg Am.</i> 1984; 9(2):222–226	339	14.74
8	The Carpal Tunnel Syndrome—a study of carpal canal pressures. Gelberman RH, Hergenroeder PT, Hargens AR et al. <i>J Bone Joint Surg Am.</i> 1981; 63(3):380–383	292	11.23
9	Complications of Colles fractures. Cooney WP, Dobyns JH, Linscheid RL. <i>J Bone Joint Surg Am.</i> 1980; 62(4):613–619.	277	10.26
10	Interfascicular nerve grafting of median and ulnar nerves. Millesi H, Berger A, Meissl G. <i>J Bone Joint Surg Am.</i> 1972; 54(4):727–750	266	7.60
11	The triangular fibrocartilage complex of the wrist—anatomy and function. Palmer AK, Werner FW. <i>J Hand Surg Am.</i> 1981; 6(2):153–162	254	9.77
12	Kinematics of wrist—experimental study of radial–ulnar deviation and flexion–extension. Youm Y, McMurtry RY, Flatt AE et al. <i>J Bone Joint Surg Am.</i> 1978; 60(4):423–431	247	8.52
13	Triangular fibrocartilage complex lesions—a classification. Palmer AK. <i>J Hand Surg Am.</i> 1989; 14(4):594–606	235	13.06
14	Objective methods for determining the functional value of sensibility in the hand. Moberg E. <i>J Bone Joint Surg Br.</i> 1958; 40(3):454–476	232	4.73
15	Management of the fractured scaphoid using a new bone screw. Herbert TJ, Fisher WE. <i>J Bone Joint Surg Br.</i> 1984; 66(1):114–123	224	9.74
16	Fracture of the carpal navicular—diagnosis, non-operative treatment, and operative treatment. Russe O. <i>J Bone Joint Surg Am.</i> 1960; 42(5):759–768	216	4.60
17	Endoscopic release of the carpal tunnel—a randomized prospective multicenter study. Agee JM, McCarroll HR, Tortosa RD et al. <i>J Hand Surg Am.</i> 1992; 17(6):987–995	209	13.93
18	Accelerated healing of distal radius fractures with the use of specific, low-intensity ultrasound—a multicenter, prospective, randomized, double-blind, placebo-controlled study. Kristiansen TK, Ryaby JP, McCabe J et al. <i>J Bone Joint Surg Am.</i> 1997; 79(7):961–973	195	19.50
19	Ligament reconstruction for painful thumb carpometacarpal joint. Eaton RG, Littler JW. <i>J Bone Joint Surg Am.</i> 1973; 55(8):1655–1666	195	5.74
20	Digital function following flexor tendon repair in zone II—a comparison of immobilization and controlled passive motion techniques. Strickland JW, Glogovac SV. <i>J Hand Surg Am.</i> 1980; 5(6):537–543	194	7.19
21	Relative tension and potential excursion of muscles in the forearm and hand. Brand PW, Thompson DE. <i>J Hand Surg Am.</i> 1981; 6(3):209–219	192	7.38
22	The SLAC wrist—scapholunate advanced collapse pattern of degenerative arthritis. Watson HK, Ballet FL. <i>J Hand Surg Am.</i> 1984; 9(3):358–365	189	8.22
23	Carpal tunnel release—a prospective, randomized assessment of open and endoscopic methods. Brown RA, Gelberman RH, Seiler JG. <i>J Bone Joint Surg Am.</i> 1993; 75(9):1265–1275	182	13.0
24	The Carpal Tunnel Syndrome—a clinical and anatomic study. Tanzer RC. <i>J Bone Joint Surg Am.</i> 1959; 41(4):626–634	175	3.65
25	Colles fracture—a study of 2000 cases from the New York State Workmen's Compensation Board. Bacorn RW, Kurtzke JF. <i>J Bone Joint Surg Am.</i> 1953; 35(3):643–658	174	3.22
26	Colles fractures—functional bracing in supination. Sarmiento A, Pratt GW, Berry NC et al. <i>J Bone Joint Surg Am.</i> 1975; 57(3):311–317	172	5.38
27	Effects of graded compression on intraneural blood flow—an in vivo study on rabbit tibial nerve. Rydevik B, Lundborg G, Bagge U. <i>J Hand Surg Am.</i> 1981; 6(1):3–12	171	6.58
28	Open reduction and internal fixation of displaced, comminuted intra-articular fractures of the distal end of the radius. Bradway JK, Amadio PC, Cooney WP. <i>J Bone Joint Surg Am.</i> 1989; 71(6):839–847.	167	9.28
29	Successful replantation of a completely cut-off thumb—case report. Komatsu S, Tamai S. <i>Plast Reconstr Surg.</i> 1968; 42(4):374–377	165	4.23
30	Ulnar variance determination. Palmer AK, Glisson RR, Werner FW. <i>J Hand Surg Am.</i> 1982; 7(4): 376–379	164	6.56
31	Colles fracture—does the anatomical result affect the final function? McQueen M, Caspers J. <i>J Bone Joint Surg Br.</i> 1988; 70(4):649–651	162	8.53

Table 1 (continued)

Fifty most highly cited articles in hand surgery As of January 1, 2010		Total citations	Citations per year
32	The repeatability of testing with Semmes-Weinstein monofilaments. Bellkrotoski J, Tomancik E. <i>J Hand Surg Am.</i> 1987; 12(1):155–161	159	7.95
33	Carpal dislocations—pathomechanics and progressive perilunar instability. Mayfield JK, Johnson RP, Kilcoyne RK. <i>J Hand Surg Am.</i> 1980; 5(3):226–241	158	5.85
34	Factors affecting functional outcome of displaced intra-articular distal radius fractures. Trumble TE, Schmitt SR, Vedder NB. <i>J Hand Surg Am.</i> 1994; 19(2):325–340	156	12.0
35	Effects of early intermittent passive mobilization on healing canine flexor tendons. Gelberman RH, Woo SLY, Lothringer K et al. <i>J Hand Surg Am.</i> 1982; 7(2):170–175	156	6.24
36	Carpal Tunnel Syndrome—results of a prospective trial of steroid injection and splinting. Gelberman RH, Aronson D, Weisman MH. <i>J Bone Joint Surg Am.</i> 1980; 62(7):1181–1184	156	5.78
37	External pin fixation for unstable Colles fractures. Cooney WP, Linscheid RL, Dobyns JH. <i>J Bone Joint Surg Am.</i> 1979; 61(6):840–845	156	5.57
38	Surgical management of basal joint arthritis of the thumb—ligament reconstruction with tendon interposition arthroplasty. Burton RI, Pellegrini VD. <i>J Hand Surg Am.</i> 1986; 11(3):324–332	152	7.24
39	Median nerve compression in the carpal tunnel—functional response to experimentally induced controlled pressure. Lundborg G, Gelberman RH, Minteerconvery M et al. <i>J Hand Surg Am.</i> 1982; 7(3):252–259	152	6.08
40	Biomechanical analysis of static forces in thumb during hand function. Cooney WP, Chao EYS. <i>J Bone Joint Surg Am.</i> 1977; 59(1):27–36	149	4.97
41	The fractured carpal scaphoid—natural history and factors influencing outcome. Leslie IJ, Dickson RA. <i>J Bone Joint Surg Br.</i> 1981; 63(2):225–230	148	5.69
42	An alternative to the classical nerve graft for the management of the short nerve gap. Dellon AL, Mackinnon SE. <i>Plast Reconstr Surg.</i> 1988; 82(5):849–856	147	7.74
43	Functional wrist motion—a biomechanical study. Palmer AK, Werner FW, Murphy D et al. <i>J Hand Surg Am.</i> 1985; 10(1):39–46	146	6.64
44	Flexor tendon forces—in vivo measurements. Schuind F, Garcia-Elias M, Cooney WP et al. <i>J Hand Surg Am.</i> 1992; 17(2):291–298	145	9.67
45	Tendon healing within the flexor digital sheath in the dog—an experimental study. Potenza AD. <i>J Bone Joint Surg Am.</i> 1962; 44(1):49–64	144	3.20
46	Ulnar nerve compression syndromes at and below wrist. Shea JD, McClain EJ. <i>J Bone Joint Surg Am.</i> 1969; 51(6):1095–1103	140	3.68
47	Flexor tendon healing and restoration of the gliding surface—an ultrastructural study in dogs. Gelberman RH, Vandeberg JS, Lundborg GN et al. <i>J Bone Joint Surg Am.</i> 1983; 65(1):70–80	135	5.63
48	Architecture of selected muscles of the arm and forearm—atomy and implications for tendon transfer. Lieber RL, Jacobson MD, Fazeli BM et al. <i>J Hand Surg Am.</i> 1992; 17(5):787–798.	134	8.93
49	Early active mobilization following flexor tendon repair in zone 2. Small JO, Brennen MD, Colville J. <i>J Hand Surgery Br.</i> 1989; 14(4):383–391	133	7.39
50	Nerve gap: suture under tension vs. graft. Terzis J, Faibisoff B, Williams HB. <i>Plast Reconstr Surg.</i> 1975; 56(2):166–170.	133	4.16

from all hand-surgery-related topics, a search was done for the term “hand surgery” and the total number of articles identified, followed by a search for each of the aforementioned categories (i.e., “scaphoid fracture” or “distal radius fracture”). Next, the number of articles in each of these specific categories was divided by the total number of indexed “hand surgery” articles to result in a percentage of the total articles per category (i.e., scaphoid articles/total hand surgery articles %). The 50 most highly cited articles and all articles related to hand surgery were compared; analysis was performed using a Pearson correlation.

Lastly, the educational relevance of these papers was assessed by comparing these articles to published lists of “classic” papers in hand surgery [15] and to Stern’s Selected Readings in Hand Surgery used for educational purposes [12].

Statistical Analysis

Statistical analysis was performed using a Pearson correlation between groups, with an absolute value closer to 1 indicating greater correlation.

Results

Fifty articles were identified as the most highly cited within the hand surgery literature (see Table 1). The number of total citations per article ranged from 133 to 553 (mean 210), and the number of citations per year ranged from 5.79 to 30.6 (mean 8.50). Thirty-six of these articles were found to be consistently highly cited since publication, defined as more than seven citations

per year. These highly cited articles were published in five of the six searched journals.

Within the top 50 highly cited articles, the most commonly encountered clinical topics were distal radius fracture ($n=10$, 20%), carpal tunnel syndrome ($n=8$, 16%), and flexor tendon repair ($n=6$, 12%). Other clinical subjects included wrist kinematics ($n=4$), TFCC ($n=3$), scaphoid fracture and management ($n=3$), wrist instability ($n=3$), and nerve repair/grafting ($n=3$; see Fig. 1). Half of these articles were published in the 1980s (see Fig. 2).

There were 31 clinical articles and 19 experimental articles in the group (see Fig. 1 for distribution). Of the clinical articles, 16 were therapeutic studies, ten were prognostic studies, and five were diagnostic studies. Most clinical studies assessed the outcomes of an intervention ($n=17$), others described an anatomical or functional observation ($n=12$), introduced an innovation ($n=12$), presented a discovery or classification ($n=8$), or validated a questionnaire ($n=1$). There were no review articles and only three randomized trials among the clinical studies. When comparing the distribution of these topics in the 50 most highly cited articles and the distribution of all published indexed articles devoted to these topics, there was a moderate Pearson correlation ($\rho=0.71$).

Twenty-three of the 50 articles were on the selected reading list in hand surgery, thus considered important in education of residents and fellows. However, only four of these 50 articles were referenced in Wilgis' paper about classic articles in hand surgery [15].

Discussion

In the past 60 years, the field of hand surgery has expanded from the treatment of primarily traumatic injuries to a

Fig. 1 Distribution of topics, 50 most highly cited articles

Fig. 2 Decade of publication, 50 most highly cited articles

comprehensive surgical discipline dealing with all hand and upper extremity pathology. The related body of scientific literature has increased in commensurate fashion. There have been few prior attempts to identify classic or high-impact papers in hand surgery and each has used different selection criteria, most of which have been subjective. In Wilgis' paper three subjective criteria were used: (1) the paper must establish or refine a technique or concept, (2) the new technique or concept must survive the passage of time, and (3) the presented material must change the course of treatment [15]. Similarly, Stern's Selected Readings in Hand Surgery were chosen at the discretion of an experienced senior surgeon.

Although these criteria provide a reasonable way to identify important and relevant papers, we sought to use objective criteria to determine which studies have been most cited and, by correlation, most impactful in the primary hand surgery literature. Citation analysis is one of the most widely used methods of such bibliometrics, and quantifies the number of times a particular article has been referenced by subsequent authors [7]. Although there are some potential sources of bias [11], it remains an objective and valid way to quantify the impact of a scientific publication over time. In fact, recent articles in the plastic surgery [10] and orthopedic surgery [8] literature have used citation analysis to identify significant articles.

In this study, we identified the 50 most highly cited articles in the primary hand surgery literature using citation analysis of a Thomson/Reuters Web of Knowledge literature search. There was a moderate thematic correlation between these articles and all publications in the hand surgery literature. Twenty-five of the 50 articles were published in the 1980s; however, seven were published in the 1990s indicating that seminal contributions continue to be published. In fact, it may take 15 years or more for articles to reach a peak in their overall citation [10], which may partially explain this finding. The second most cited article [9] was published somewhat recently, in 1993. It is clear that articles published at an earlier date have had more time to be cited; therefore

analyzing articles by citation/year provides another way to assess their true impact independent of short-lived trends.

We sought to evaluate the studies' impact alone without evaluating study design, which has been addressed in previous publications. In one retrospective review of 2,236 hand-related studies, Chung et al. identified that the majority of studies were retrospective (45%) or prospective cohort (39%), while only 8% were randomized clinical trials [6]. The most highly cited studies identified here encompass a myriad of study designs and largely reflect past experience of retrospective and prospective cohort studies with few prospective or high levels of evidence randomized studies. More rigorous scientific investigation is clearly needed in the primary hand surgery literature.

Our data characterize some of the most common clinical, scientific, and educational aspects within the hand surgery literature. With regard to clinical relevance, the most commonly cited articles in our series pertained to distal radius fractures, carpal tunnel syndrome, and flexor tendon repair. This is reflective of their incidence in the USA each year; it is estimated that the number of distal radius and/or ulnar fractures is greater than 600,000 [5], and that there are more than 400,000 carpal tunnel operations performed per year in the USA [14]. Other topics, such as phalangeal fractures, interventions for arthritis, and nerve grafting are more difficult to study and less well characterized epidemiologically. High-impact articles do affect the practice of hand surgery, as they guide practitioners clinically and help to better define the specialty as a whole.

The scientific and research relevance of these articles was substantiated by the correlation of these articles to all indexed hand surgery articles. This indicates that the distribution of topics in the 50 most highly cited articles is similar to all published "hand surgery" articles, and is reflective of scientific and research efforts in the field. This list is also educationally relevant, as 23 of these articles were also found on Stern's selected reading list in hand surgery—considered an important educational tool for residents and fellows. However, only four of the highly cited articles were found in Wilgis' paper which likely reflects his more historical analysis prior to the advent of many hand- and orthopedic-specific journals.

There are some limitations to this study, as we evaluated articles retrospectively from six journals and did not include studies from other journals not dedicated to hand surgery. Additionally, citation analysis has biases that potentially limit its applicability but does provide the most objective way to identify high-impact studies in a particular field. Using citation numbers exclusively to determine the importance of an article may not be entirely reliable; articles may be blindly cited simply because other articles about a particular subject also cite that article. The number of times an article has been cited is only one of many ways to define an article's importance; other ways include questionnaires/surveys of practicing hand

surgeons and critical analysis of large review articles. Citation analysis is most appropriately used as a comparison between journals *within* a similar discipline (i.e., orthopedic or plastic surgery), as the overall number of citations and publications will be relatively similar as compared to more diverse fields of medicine [4]. In this study all included journals have a similar focus and, as such, citation analysis affords an appropriate means to compare the impact of published articles. Two additional biases include the date limitations of a Thomson/Reuters Web of Knowledge literature search, which may be limited in the early 1900s given its electronic search, and the English-only nature of the searched journals.

The 50 articles identified in this study reflect the most common clinical, scientific, and educational efforts of the field. They will serve as a resource for aspiring hand surgeons and will help to guide future research in these areas.

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