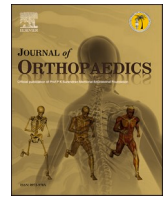




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The fifty most-cited articles regarding midshaft clavicle fractures

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A B S T R A C T

Introduction: The clavicle is the most frequently fractured bone in the human body, and up to 80% of clavicle fractures occur in the middle third diaphyseal region of the clavicle (midshaft). We conducted a bibliometric analysis to identify and evaluate the 50 most-cited publications pertaining to midshaft clavicle fractures (MCF). **Materials and methods:** Two independent reviewers conducted separate queries on Web of Science in December 2021 for “midshaft clavicle fractures”. The publications yielded were organized from highest to lowest number of citations. We included articles, review articles, and editorial materials and excluded other document types. Both reviewers independently reviewed all abstracts until 50 studies pertaining to MCF were included.

Theory: We hypothesized that most articles would be published between 2000 and 2019, pertain to outcomes, and those with a greater (lower numeric) level of evidence would correlate with number of citations.

Results: The most prolific decade was from 2010 to 2019, with 50% (25/50) of articles published. Average citation density was 6.3 ± 5.5 (range, 1.3–33.1), defined as the average number of citations per year since publication. The median level of evidence (LOE) was 3.5 (IQR: 3). One-way ANOVA tests were used to compare the effects of LOE on total citations and citation density. There were statistically significant differences in total citations (F value = 12.07, $p = 0.001$) and citation density (F value = 21.14, $p < 0.001$) between LOE groups. The median number of total citations, grouped by LOE of 1 through 5, were as follows: 110, 66, 66, 51, 52.

Conclusions: This review provides an overview of the 50 most cited papers regarding MCF. This should be used as a reference for physicians and other providers who treat patients with MCF for treatment guidance and for those in teaching roles as a student and resident/fellow educational resource.

1. Introduction

The clavicle is the most frequently fractured bone in the human body, representing up to 5% of all fractures. Up to 80% of clavicle fractures occur in the middle third diaphyseal region of the clavicle, or midshaft.¹ Midshaft clavicle fractures (MCF) were traditionally treated nonoperatively with a sling to the affected upper extremity or figure-of-eight brace. However, a growing body of research has shown benefits of early operative intervention and potential poor sequelae of conservative treatment in certain circumstances. Suboptimal results include pain and deformity, decreased shoulder strength, and decreased patient outcome scores compared to surgical intervention. This has caused an influx of new research evaluating nonoperative versus operative treatment of MCF and describing indications for each.^{1,2} Much of this literature indicates surgical treatment for young, active patients with clavicle shortening greater than 2 cm to prevent nonunion or symptomatic malunion, and preserve shoulder strength and function.^{2–4}

The increase in MCF investigation may help to explain the increase in operative fixation of MCF over the last two decades, via both plate and

intramedullary fixation.^{5–9} Kurowicki et al. demonstrated a significant increase in open reduction internal fixation (ORIF) of MCF after the publication of supporting level 1 evidence research ($p = 0.003$), with a significant positive correlation between total annual MCF and ORIF use ($r = 0.853$, $p = 0.007$).⁸ Between 1999 and 2011, operative fixation of MCF significantly increased.⁹ Further, the rate of operative fixation of MCF increased 290% from 2005 to 2010.⁵ This trend is also evident in pediatrics. Although operative fixation has increased, differences in treatment remain based on socioeconomic factors and surgeon preference. Patients who are white, high-income, and privately insured have higher rates of operative treatment of MCF compared to their counterparts.⁵

To generate a concise, yet comprehensive, understanding of the research pertaining to MCF management, it is important to evaluate the most influential articles in this large and often conflicting body of literature. This can be accomplished by conducting a bibliometric analysis to review and analyze related articles based on a quantifiable ranking, such as number of citations, and provide insight to current MCF management, and guide future research endeavors within this specific

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topic.¹⁰ Our aim was to identify and evaluate the 50 most-cited publications pertaining to MCF in order to provide an educational paper that can be used by those who evaluate and manage MCF. We hypothesized that most articles would be published over the last two decades (2000–2010, 2011–2020) and pertain to outcomes. We also hypothesized that articles with a stronger level of evidence (LOE) would have more citations.

2. Materials and Methods

2.1. Methodology

The Web of Science Core Collection is a search engine of scholarly publications from 1945 to present. Two independent reviewers conducted separate queries on Web of Science in December 2021 for “midshaft clavicle fractures”. The results were organized from greatest to least number of citations. We included “articles”, “review articles”, and “editorial materials”. We excluded other document types. We did not set inclusion and exclusion criteria based on publication year, category, language, or LOE. Both reviewers independently reviewed all abstracts, excluding studies that did not pertain to MCF, until 50 studies were included. The reviewers compared their individual lists to compile an agreed upon final list of the top 50 publications.

Variables collected included authors, manuscript title, document type, total citations, publication year, and country of origin. LOE for each article was determined by one reviewer based on the Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence.¹¹ We categorized each article into one of six thematic categories previously established by Allegra et al. in a review of the literature on SLAP lesions.¹⁰ The categories included: (I) Physical Exam, (II) Diagnostics, (III) Surgical Management, (IV) Outcomes, (V) Anatomy and/or Classification, and (VI) Comprehensive Review.

2.2. Statistical analysis

Web of Science (Philadelphia, Pennsylvania), R Studio (Boston, Massachusetts), and Microsoft Excel (Redmond, Washington) were used to summarize and analyze data from the selected articles. Normally distributed variables were reported as mean and standard deviation (SD). Variables with skewed distribution were reported as median and interquartile range (IQR). Correlation coefficients (r) were calculated to analyze the relationships between quantitative variables. One-way ANOVA tests were used to determine differences between the mean total citations or citation densities of different LOE groups. P values < 0.05 were considered statistically significant.

3. Theory

We hypothesized that most articles would be published between 2000 and 2019 and pertain to outcomes. We also hypothesized articles with a stronger level of evidence would have more citations.

4. Results

Our initial search yielded 544 articles. Within our final included cohort, the 50th most-cited article was the 58th article to appear in the initial search. Eight studies were excluded upon review because they did not meet inclusion criteria. Seven of the eight studies pertained to clavicle fractures but were not specific to *midshaft* fractures and one pertained to Achilles tendon rupture (Fig. 1). The list of top 50 most cited publications is displayed in Table 1.^{2,4,12–59} Document types included articles (84%, 42/50) and reviews (16%, 8/50).

Year of publication ranged from 1991 to 2017. The most prolific years of publication were 2007 (12%, 6/50), 2011 (12%, 6/50), and 2012 (12%, 6/50) (Fig. 2). The most prolific decade was from 2010 to 2019, with 50% (25/50) of articles published. This was closely followed

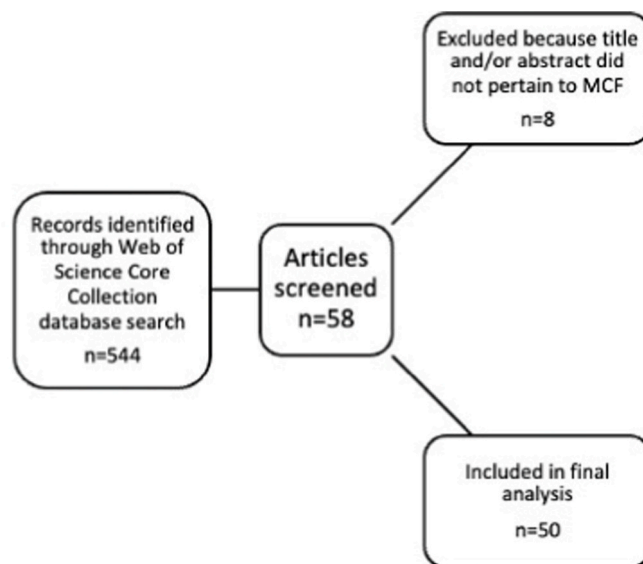


Fig. 1. Modified PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart.

by 2000–2009, with 21 (42%) publications (Fig. 3).

Total citations ranged from 37 to 529 per article, with a median of 61.5 (IQR: 37.25). Average citation density was 6.3 ± 5.5 (range, 1.3–33.1), defined as the average number of citations per year since publication. There was no significant correlation between years since publication and citation density ($r = 0.16$, $p = 0.26$).

Nineteen authors authored more than one Top 50 publication, not exclusive to first authorship. The most common author was MD Mckee (16%, 8/50), followed by RM Houwert (8%, 4/50), EH Schemitsch (8%, 4/50), PJ Millett (6%, 3/50), and LM Wild (6%, 3/50). The majority of publications were from the United States (38%, 19/50), Canada (20%, 10/50), and the Netherlands (14%, 7/50). Multiple publications had multiple countries of origin, with 16 unique countries (Fig. 4). Manuscripts were most often published in Journal of Bone and Joint Surgery-American Volume (20%, 10/50) and Journal of Shoulder and Elbow surgery (20%, 10/50), followed by Journal of Orthopaedic Trauma (16%, 8/50) (Fig. 5).

The selected articles encompassed all levels of evidence (LOE). The median LOE was 3.5 (IQR: 3). The most common LOE were 4 (38%, 19/50) and 1 (30%, 15/50), followed by 5 (12%, 6/50), 2 (10%, 5/50), and 3 (10%, 5/50). One-way ANOVA tests were used to compare the effects of LOE on total citations and citation density. There were statistically significant differences in total citations (F value = 12.07, $p = 0.001$) and citation density (F value = 21.14, $p < 0.001$) between LOE groups. The median number of total citations, grouped by LOE of 1 through 5, were as follows: 110, 66, 66, 51, 52 (Fig. 6).

The mean citation density, grouped by LOE of 1 through 5, were as follows: 11.0, 6.3, 5.4, 3.5, 4.2.

The most common thematic category discussed was (IV) Outcomes (38/50, 76%), followed by (VI) Comprehensive Review (9/50, 18%). Two articles' (4%) pertained to (V) Anatomy and/or Classification and one article (2%) to (III) Surgical Management. No articles focused on (I) Physical Exam or (II) Diagnostics (Fig. 7).

5. Discussion

Optimal treatment for middle third clavicle fractures continues to be debated within the literature. Our results show that MCF has become a topic of more intense investigation within the orthopaedic community as of the mid-2000s, with 92% of our list published within the last 2 decades (2000–2019). Our results show the majority of our most often

Table 1
Fifty most-cited articles regarding midshaft clavicle fractures.

Rank	Article Title	First Author	Year	Citation Count	Citation Density (Citations per Year since Publication Year)	Journal	Country	Category ^a	LOE ^b
1	Nonoperative treatment compared with plate fixation of displaced midshaft clavicular fractures - A multicenter, randomized clinical trial	McKee, MD	2007	529	33.06	JOURNAL OF BONE AND JOINT SURGERY-AMERICAN VOLUME	Canada	IV	1
2	Treatment of acute midshaft clavicle fractures: Systematic review of 2144 fractures - On behalf of the Evidence-Based Orthopaedic Trauma Working Group	Zlowodzki, M	2005	365	20.28	JOURNAL OF ORTHOPAEDIC TRAUMA	USA	V	1
3	Deficits following nonoperative treatment of displaced midshaft clavicular fractures	McKee, MD	2006	292	17.18	JOURNAL OF BONE AND JOINT SURGERY-AMERICAN VOLUME	Canada	IV	1
4	Operative Versus Nonoperative Care of Displaced Midshaft Clavicular Fractures: A Meta-Analysis of Randomized Clinical Trials	McKee, RC	2012	188	17.09	JOURNAL OF BONE AND JOINT SURGERY-AMERICAN VOLUME	Canada	VI	1
5	Midshaft malunions of the clavicle	McKee, MD	2003	165	8.25	JOURNAL OF BONE AND JOINT SURGERY-AMERICAN VOLUME	Canada	IV	1
6	Treatment of clavicle fractures: current concepts review	Van der Meijden, OAJ	2012	124	11.36	JOURNAL OF SHOULDER AND ELBOW SURGERY	USA	VI	1
7	Effects of plate location and selection on the stability of midshaft clavicle osteotomies: A biomechanical study	Iannotti, MR	2002	113	5.38	JOURNAL OF SHOULDER AND ELBOW SURGERY	USA	IV	5
8	Systematic review of the complications of plate fixation of clavicle fractures	Wijdicks, FJG	2012	103	9.36	ARCHIVES OF ORTHOPAEDIC AND TRAUMA SURGERY	Netherlands	VI	1
9	Plate fixation of fresh displaced midshaft clavicle fractures	Shen, WJ	1999	103	4.29	INJURY-INTERNATIONAL JOURNAL OF THE CARE OF THE INJURED	Taiwan	IV	1
10	Anterior-inferior plate fixation of middle-third fractures and nonunions of the clavicle	Collinge, C	2006	100	5.88	JOURNAL OF ORTHOPAEDIC TRAUMA	USA	IV	4
11	Acute midshaft clavicular fracture	Jeray, KJ	2007	94	5.88	JOURNAL OF THE AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS	USA	VI	1
12	Biomechanical evaluation of clavicle fracture plating techniques: Does a locking plate provide improved stability?	Celestre, P	2008	92	6.13	JOURNAL OF ORTHOPAEDIC TRAUMA	USA	IV	4
13	Operative versus Nonoperative Management of Displaced Midshaft Clavicle Fractures: A Prospective Cohort Study	Kulshrestha, V	2011	81	6.75	JOURNAL OF ORTHOPAEDIC TRAUMA	India	IV	3
14	Plate Fixation Compared with Nonoperative Treatment for Displaced Midshaft Clavicular Fractures A Multicenter Randomized Controlled Trial	Woltz, S	2017	75	12.5	JOURNAL OF BONE AND JOINT SURGERY-AMERICAN VOLUME	Netherlands	IV	1
15	NONUNION OF FRACTURES OF THE MIDSHAFT OF THE CLAVICLE - TREATMENT WITH A MODIFIED HAGIE INTRAMEDULLARY PIN AND AUTOGENOUS BONE-GRAFTING	Boehme, D	1991	73	2.28	JOURNAL OF BONE AND JOINT SURGERY-AMERICAN VOLUME	USA	IV	4
16	Operative Versus Nonoperative Treatment of Midshaft Clavicle Fractures in Adolescents	Have, KLV	2010	73	5.62	JOURNAL OF PEDIATRIC ORTHOPAEDICS	USA	VI	3
17	Shaft fractures of the clavicle: current concepts	Smekal, V	2009	70	5	ARCHIVES OF ORTHOPAEDIC AND TRAUMA SURGERY	Austria	VI	1
18	Intramedullary Nailing of Clavicular Midshaft Fractures With the Titanium Elastic Nail Problems and Complications	Frigg, A	2009	70	5	AMERICAN JOURNAL OF SPORTS MEDICINE	Switzerland	IV	4
19	Length determination in midshaft clavicle fractures: Validation of measurement	Smekal, V	2008	66	4.4	JOURNAL OF ORTHOPAEDIC TRAUMA	Austria	V	4

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Table 1 (continued)

Rank	Article Title	First Author	Year	Citation Count	Citation Density (Citations per Year since Publication Year)	Journal	Country	Category ^a	LOE ^b
20	Complications of intramedullary Hagie pin fixation for acute midshaft clavicle fractures	Strauss, EJ	2007	66	4.13	JOURNAL OF SHOULDER AND ELBOW SURGERY	USA	VI	4
21	Risk Factors for Nonunion After Nonoperative Treatment of Displaced Midshaft Fractures of the Clavicle	Murray, IR	2013	64	6.4	JOURNAL OF BONE AND JOINT SURGERY-AMERICAN VOLUME	Scotland	IV	2
22	Precontoured Plating of Clavicle Fractures: Decreased Hardware-related Complications?	VanBeek, C	2011	64	5.33	CLINICAL ORTHOPAEDICS AND RELATED RESEARCH	USA	IV	3
23	Plating versus intramedullary pin or conservative treatment for midshaft fracture of clavicle: a meta-analysis of randomized controlled trials	Duan, X	2011	64	5.33	JOURNAL OF SHOULDER AND ELBOW SURGERY	China	IV	2
24	Rate of and Risk Factors for Reoperations After Open Reduction and Internal Fixation Midshaft Clavicle Fractures A Population-Based Study in Ontario, Canada	Leroux, T	2014	62	6.89	JOURNAL OF BONE AND JOINT SURGERY-AMERICAN VOLUME	Canada	IV	2
25	Is Surgery for Displaced, Midshaft Clavicle Fractures in Adults Cost-Effective? Results Based on a Multicenter Randomized, Controlled Trial	Pearson, AM	2010	62	4.77	JOURNAL OF ORTHOPAEDIC TRAUMA	USA	IV	1
26	Plate fixation versus intramedullary fixation for displaced mid-shaft clavicle fractures: a systematic review	Houwert, RM	2012	61	5.55	INTERNATIONAL ORTHOPAEDICS	Netherlands	IV	1
27	Reconstruction plates for stabilization of mid-shaft clavicle fractures: Differences between nonlocked and locked plates in two different positions	Robertson, C	2009	59	4.29	JOURNAL OF SHOULDER AND ELBOW SURGERY	USA	IV	5
28	Does delay matter? The restoration of objectively measured shoulder strength and patient-oriented outcome after immediate fixation versus delayed reconstruction of displaced midshaft fractures of the clavicle	Potter, JM	2007	59	3.69	JOURNAL OF SHOULDER AND ELBOW SURGERY	Canada	IV	4
29	Fixation of fractures of the midshaft of the clavicle with Kirschner wires - Results in 108 patients	Ngarmukos, C	1998	54	2.16	JOURNAL OF BONE AND JOINT SURGERY-BRITISH VOLUME	Thailand	IV	4
30	Minimally invasive plate osteosynthesis using 3D Printing for shaft fractures of clavicles: technical note	Jeong, HS	2014	53	5.89	ARCHIVES OF ORTHOPAEDIC AND TRAUMA SURGERY	South Korea	III	5
31	Clinical and financial comparison of operative and nonoperative treatment of displaced clavicle fractures	Althausen, PL	2013	53	5.3	JOURNAL OF SHOULDER AND ELBOW SURGERY	USA	IV	3
32	Flexible intramedullary nailing for stabilization of displaced midshaft clavicle fractures	Kettler, M	2007	53	3.31	ACTA ORTHOPAEDICA	Germany	IV	4
33	The technique of elastic-stable intramedullary nailing of midclavicular fractures	Jubel, A	2002	48	2.29	UNFALLCHIRURG	Germany	IV	4
34	Low-intensity pulsed ultrasound (LIPUS) in fresh clavicle fractures: A multi-centre double blind randomised controlled trial	Lubbert, PHW	2008	47	3.13	INJURY-INTERNATIONAL JOURNAL OF THE CARE OF THE INJURED	Netherlands	IV	1
35	The Clavicle Trial A Multicenter Randomized Controlled Trial Comparing Operative with Nonoperative Treatment of Displaced Midshaft Clavicle Fractures	Ahrens, PM	2017	45	7.5	JOURNAL OF BONE AND JOINT SURGERY-AMERICAN VOLUME	England	IV	1
36	Complications after plate fixation and elastic stable intramedullary nailing of dislocated midshaft clavicle fractures: a retrospective comparison	Wijdicks, FJ	2012	43	3.91	INTERNATIONAL ORTHOPAEDICS	Netherlands	IV	3
37	Complications of clavicle fractures treated with intramedullary fixation	Millett, PJ	2011	43	3.58	JOURNAL OF SHOULDER AND ELBOW SURGERY	USA	IV	4
38	Surgical Versus Nonsurgical Treatment for Midshaft Clavicle Fractures in Patients Aged 16 Years and Older: A Systematic Review, Meta-analysis, and Comparison of Randomized Controlled Trials and Observational Studies	Smeeing, DPJ	2017	42	7	AMERICAN JOURNAL OF SPORTS MEDICINE	Netherlands	VI	2

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Table 1 (continued)

Rank	Article Title	First Author	Year	Citation Count	Citation Density (Citations per Year since Publication Year)	Journal	Country	Category ^a	LOE ^b
39	Functional and Radiographic Outcomes of Nonoperative Treatment of Displaced Adolescent Clavicle Fractures	Schulz, J	2013	42	4.2	JOURNAL OF BONE AND JOINT SURGERY-AMERICAN VOLUME	USA	IV	4
40	Plate fixation or intramedullary fixation for midshaft clavicle fractures: a systematic review and meta-analysis of randomized controlled trials and observational studies	Houwert, RM	2016	41	5.86	JOURNAL OF SHOULDER AND ELBOW SURGERY	Netherlands	IV	2
41	A retrospective study of the association between shortening of the clavicle after fracture and the clinical outcome in 136 patients	Rasmussen, JV	2011	41	3.42	INJURY-INTERNATIONAL JOURNAL OF THE CARE OF THE INJURED	Denmark	IV	4
42	Long-term results of conservative management of midshaft clavicle fracture	Postacchini, R	2010	41	3.23	INTERNATIONAL ORTHOPAEDICS	Italy	IV	4
43	Operative Treatment of Completely Displaced Clavicle Shaft Fractures in Children	Mehlman, CT	2009	41	2.93	JOURNAL OF PEDIATRIC ORTHOPAEDICS	USA	IV	4
44	Management of Acute Clavicle Fractures	Kim, W	2008	41	2.73	ORTHOPEDIC CLINICS OF NORTH AMERICA	Canada	VI	5
45	Biomechanical comparison of the Locking Compression superior anterior clavicle plate with seven and ten hole reconstruction plates in midshaft clavicle fracture stabilization	Eden, L	2012	39	3.55	INTERNATIONAL ORTHOPAEDICS	Germany	IV	5
46	Treatment of mid-shaft clavicle fractures: A comparative study	Thyagarajan, DS	2009	40	2.86	INTERNATIONAL JOURNAL OF SHOULDER SURGERY	Wales	IV	4
47	Biomechanical Analysis of Fixation of Middle Third Fractures of the Clavicle	Drosdowech, DS	2011	39	3.25	JOURNAL OF ORTHOPAEDIC TRAUMA	Canada	IV	5
48	Functional outcome of surgical treatment of symptomatic nonunion and malunion of midshaft clavicle fractures	Rosenberg, N	2007	39	2.44	JOURNAL OF SHOULDER AND ELBOW SURGERY	England	IV	4
49	Shoulder Motion, Strength, and Functional Outcomes in Children With Established Malunion of the Clavicle	Bae, DS	2013	37	3.7	JOURNAL OF PEDIATRIC ORTHOPAEDICS	USA	IV	4
50	MIDSHAFT CLAVICLE NONUNIONS TREATED WITH INTRAMEDULLARY STEINMAN PIN FIXATION AND ONLAY BONE-GRAFT	Capicotto, PN	1994	37	1.28	JOURNAL OF ORTHOPAEDIC TRAUMA	USA	IV	4

^a Categories: (I) Physical Exam, (II) Diagnostics, (III) Surgical Management, (IV) Outcomes, (V) Anatomy and/or Classification, and (VI) Comprehensive Review.

^b LOE, level of evidence.

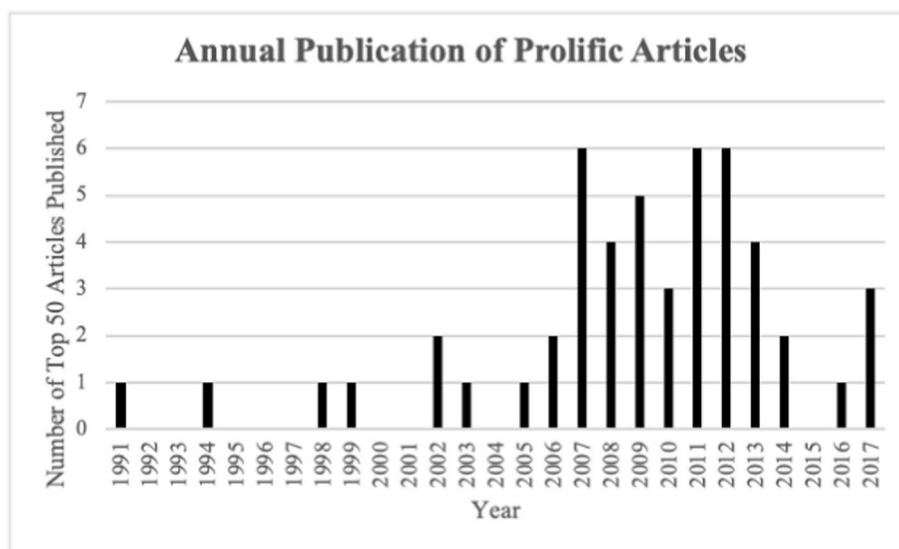


Fig. 2. Publication of Top 50 articles by year.

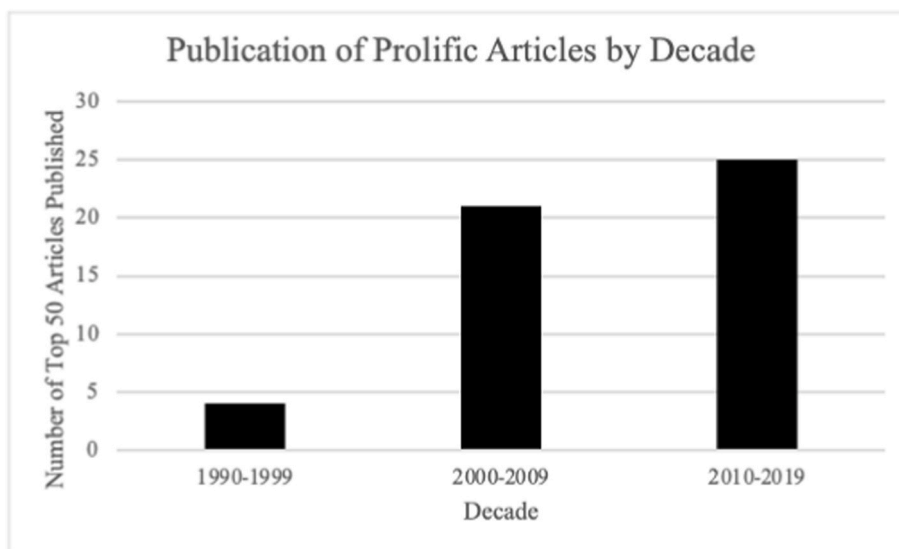


Fig. 3. Publication of Top 50 articles by decade.

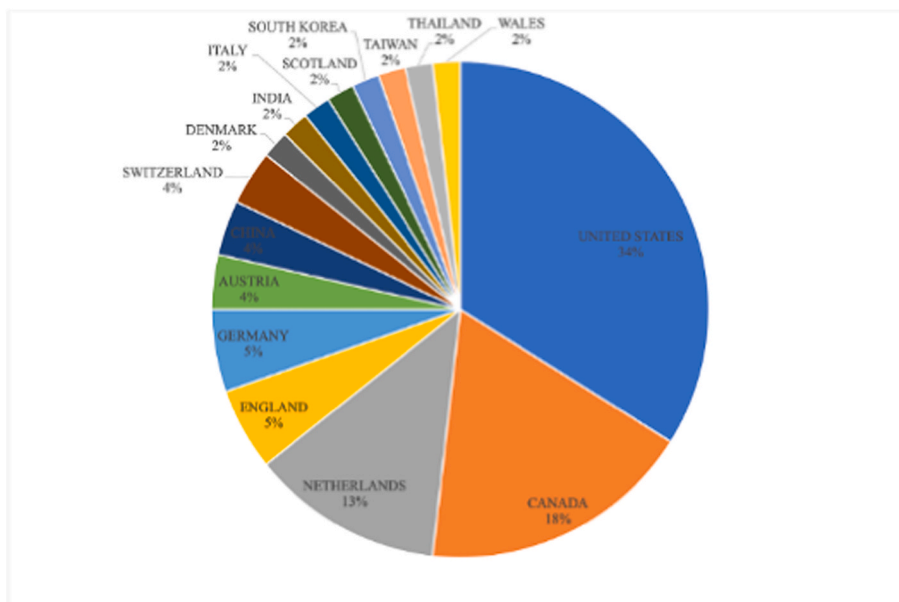


Fig. 4. Journal articles by country of origin.

cited studies were published in the years 2007–2013 (Fig. 2). The research query tends to focus on comparing outcomes with different techniques, as evidenced by the vast majority of Top 50 articles focusing on thematic category (IV) Outcomes. With the increase in research about MCF, there has been a shift in treatment modalities and indications for each treatment arm.

In the early years of management of MCF, patients were traditionally treated nonoperatively, either with sling or figure-of-eight immobilization, with sling immobilization later becoming the preferred treatment modality. However, in the early 2000's, studies regarding nonunion in displaced MCF treated nonoperatively raised concern, and operative fixation became increasingly discussed. General consensus for operative fixation has been established for a specific set of parameters, however less concrete parameters are described for type of fixation when surgical intervention is appropriate. The data shows that most of the top 50 publications are related to operative and non-operative management of MCF. The indications for surgery are: a completely displaced midshaft

fracture with >2 cm shortening, evidence of skin tenting implying potential impending open fracture, open fractures, floating shoulders with completely displaced clavicle fracture, severe angulation or obvious deformity, neurovascular compromise, polytrauma, and symptomatic nonunion.^{37,60} Surgical treatment is also favored in patients with high functional demands or overhead athletes. Nonoperative management is often utilized when the above criteria are not met.

Many of the top 50 most cited articles were produced by the same authors, either as the primary investigator or a co-author. McKee has been a leading researcher on this topic. He is the principal investigator of 16% of the top 50 most cited articles, an author on the top five most cited articles, and had the most cited papers overall. McKee et al. and The Canadian Orthopaedic Trauma Society (COTS) published their landmark randomized control trial in 2007, which is the single most cited manuscript in our study, supporting operative fixation for displaced MCF. They defined displaced midshaft clavicle fractures as 100% displaced or greater than 2 cm of shortening. They found that operative



Fig. 5. Publications by journal.

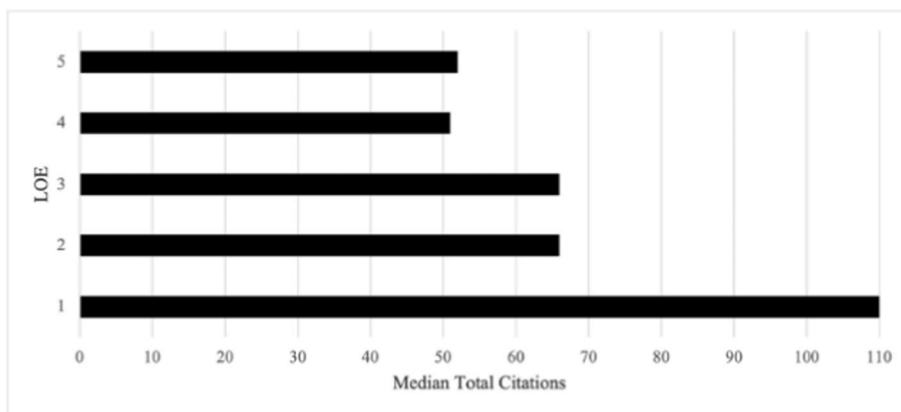


Fig. 6. Median total citations by level of evidence (LOE).

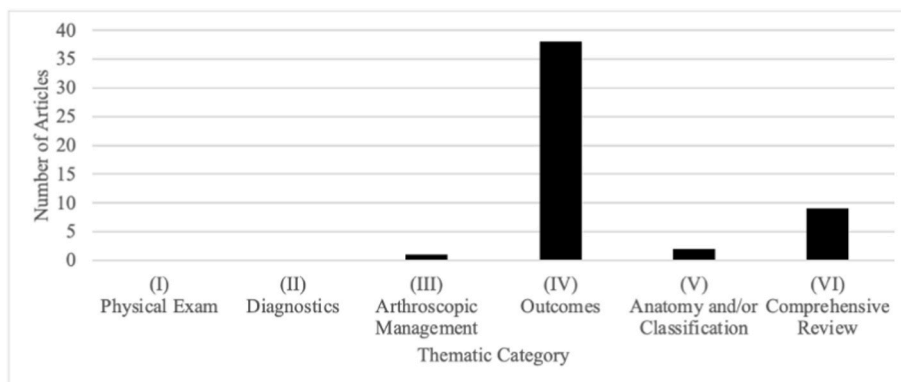


Fig. 7. Number of articles by thematic category discussed.

fixation of displaced fractures significantly reduced the rates of malunion and nonunion when compared to conservative treatment, which is now well-supported in the literature. They also reported a faster time to union in a randomized operative group.³⁷

The next most cited authors on this topic, Schemitsch and Houwert, each produced 8% of the most cited articles. Schemitsch has worked closely with McKee, being involved with three of the top five manuscripts. They concur on the role of operative management for MCF that were deemed operative by the above stated criteria, both primarily and

in a delayed setting with late reconstruction of nonunion and malunion. Schemitsch et al. reports favorable patient outcome scores and restoration of muscle strength similar to that seen with immediate fixation, albeit with mild decreased endurance, via corrective osteotomy for malunion.^{22,35,40}

Houwert has largely focused on operative fixation of MCF, the outcomes of plate fixation versus intramedullary nail, and the complications associated with internal fixation. In their work, a meta analysis supported the role of operative fixation for MCF for clavicle fractures

that were displaced, open fractures, or impending open fractures, showing decreased nonunions, malunions, and accelerated return to work. They found no significant difference in function or nonunion when comparing plate versus intramedullary fixation. However, they reported increased risk of re-intervention, implant failure, and re-fracture following removal of hardware in MCF treated with plate fixation as opposed to intramedullary fixation. Their work provided support for internal fixation of MCF, while sharing the subsequent complications of doing so. Complication rates of IMN fixation for MCF are as high as 50%. The most common complications are superficial infection around exposed pin, pin extrusions, skin irritation or breakdown, and nonunion.^{19,45,46,55,61}

When analyzing the LOE of the manuscripts, 15 (30%) Level I studies made the top 50 most-cited publications on MCF. The top six manuscripts were all Level 1 studies. The median LOE was 3.5 (IQR: 3). It is notable that 50% of the top 50 articles were Level 4 and 5. This may demonstrate a need for more consistent, high caliber research. The mean and median number of citations were highest for Level 1 articles and sequentially decreased as the LOE decreased, which demonstrates higher quality evidence is more cited.

The majority of the most cited papers focused on surgical versus non-surgical outcomes or were comprehensive review papers. Seventy-six percent of the top 50 papers were outcome-based. There were no papers included that fell under diagnostics or physical exam. The stark difference likely highlights that imaging and physical exam for MCF is widely agreed upon, whereas the management is more frequently debated.

Identifying and performing a bibliometric analysis on the top 50 most cited papers on MCF is important from a clinical and educational standpoint. The research done within the top 50 has helped guide treatment, defined guidelines for surgery, and reviewed clinical outcomes. This paper allows clinicians to find the most widely cited research to help guide their management of a patient who sustains a MCF.

Limitations

Our review sought to concisely present the top 50 most cited manuscripts within the current literature regarding evaluation and management of MCF. The primary limitation of this investigation was the use of one database (Web of Science) to search the literature. However, using one platform ensured uniform citation counting. This allowed us to appropriately rank articles from most to least cited using the same citation-counting algorithm. While our presented list captures critical knowledge pertaining to this topic, we acknowledge there are numerous manuscripts not captured within the “most cited” list which contribute to management today.

6. Conclusions

This review provides a quantitative overview of the top 50 most cited papers regarding midshaft clavicle fractures. This should be used as a reference for providers who treat patients with MCF for treatment guidance and for those in teaching roles as a student/resident/fellow educational resource.

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Informed consent

N/A.

Institutional ethical committee approval

IRB Exempt.

Authors' contributions

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Declaration of competing Interest

None.

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