

# Characteristics and Trends of Highly Cited Articles in Calcaneus Fracture Research

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## Abstract

**Background:** Despite significant effort expended toward exploring fracture patterns, surgical timing, surgical approaches, and possible implants within the calcaneus fracture literature, treatment is still fraught with complications and controversy. This study aims to conduct a citation analysis of the most cited articles related to calcaneus fractures to highlight the most historically influential articles, as well as the more recent breakthrough articles that are leading change within the field.

**Methods:** A literature search was performed via Scopus on September 20, 2021 using the terms “(calcaneus OR calcaneal OR hindfoot) AND (fracture OR injury)” to search “article title, abstract, and keywords” of all primary and review articles. Search results were rigorously reviewed to ensure appropriateness for this study. The 50 highest total cited included articles were analyzed. Title, authors, journal, country of origin, institution, year of publication, citation variables (total citation count, total citation density, citation count from the last 5 years, and 5-year citation density), and level of evidence were collected for each article. One-way analysis of variance with post hoc testing was used to identify differences in citation variables and level of evidence. Pearson correlation was used to directly compare different citation variables.

**Results:** The total citation count average was  $178 \pm 33$ , with a total citation density average of  $9 \pm 2$ . The year of publication for the 50 articles ranged from 1948 to 2014, with a median year of 1999. Roy W. Sanders was the most productive author in the field, authoring 6 articles and lead authoring 3. The most frequent level of evidence was IV with 19 articles. There was a strong correlation between total citation density and 5-year citation density. The article level of evidence showed no impact on the included measures of an article’s influence.

**Conclusion:** This study successfully analyzes and presents the characteristics among the highest cited articles related to calcaneus fractures. The provided characterization of influential works and authors highlights trends, impactful findings, and future areas of focus within calcaneus fracture literature.

**Level of Evidence:** Review Article.

**Keywords:** calcaneus fracture, citation analysis, citation count, citation density

## Introduction

The calcaneus is both the largest and most commonly fractured tarsal bone.<sup>14</sup> Significant effort has been expended exploring fracture patterns, surgical timing, surgical approaches, and possible implants within the literature.<sup>12</sup> Despite this continued focus and numerous surgical advancements, treatment is still fraught with complications

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and controversy.<sup>13</sup> A large majority of calcaneus fractures are intraarticular. These can be treated operatively with open reduction internal fixation (ORIF), primary arthrodesis, or secondary arthrodesis.<sup>12,27</sup> Common associated complications include delayed wound healing, osteomyelitis, and posttraumatic arthritis, all of which carry significant morbidity.<sup>6</sup> As the body of literature regarding calcaneus fractures continues to grow, an analysis of the most impactful literature is justified to direct future research and pay tribute to the highest contributing work within the field.

Citation analyses are a validated method for collecting and identifying impactful studies across many scientific and medical fields.<sup>9–11</sup> Because total citation count is thought to be predictive of an article's overall impact, focusing on total citation count through careful analysis allows authors to present both empirical and subjective findings related to the most influential works within a field.<sup>18</sup> Citation analyses have been used throughout all fields of orthopaedics, including foot and ankle.<sup>1,4,8,15,17,19,25</sup> However, to our knowledge, there are no citation analyses within the literature related specifically to calcaneus fractures.

This study aims to conduct a citation analysis of the most cited articles related to calcaneus fractures in an effort to highlight the most historically influential articles, as well as the more recent breakthrough articles that are leading change within the field. As the calcaneus fracture literature is ripe with disagreement and recent advancement, we hypothesize that the highest cited articles will have the most historically influential impact and will also play a significant role as the basis for recent studies to build on.

## Materials and Methods

A literature search of articles analyzing calcaneus fractures was performed via Scopus (Elsevier) on September 20, 2021, using the terms “(calcaneus OR calcaneal OR hind-foot) AND (fracture OR injury)” to search “article title, abstract, and keywords” of all primary and review articles. Article title, authors, journal, country of origin, institution, year of publication, total citation count, total citation density (2020—year of publication), citation count from the last 5 years, and 5-year citation density were collected for each article. All search results were rigorously reviewed to ensure appropriateness for this study. Unrelated articles were removed from consideration. The 50 highest total cited remaining articles were then analyzed.

The level of evidence of each article was assessed in accordance with the *Journal of Bone & Joint Surgery's* guidelines or recorded directly from the abstract, if stated.<sup>28</sup> Total citation counts for each author were calculated by summing the total citations for each article in the 50 highest cited articles in which they contributed. A weighted analysis was also performed by assigning each author of the most cited article 50 points, with a decrease in 1 point awarded to

the authors of each subsequently ranked article. Total points were then summed, generating a weighted score for each author. The gross analysis of authorship consisted of calculating the number of articles by each author in the cohort of 50 articles. The relative author position for each article was not factored into the analysis. The h-index score for each author was collected via Scopus.

A 1-way analysis of variance with post hoc testing was used to identify differences in total citation density, 5-year citation density, total citation count, and 5-year citation count with differing levels of evidence. Pearson correlation was used to compare total citation count and total citation density, total citation count and 5-year citation density, total citation density and 5-year citation density, years since publication and total citation density, and years since publication and total citation count. All statistical analyses and calculations were performed using SPSS, version 23 (IBM).

## Results

The total citation count average was  $178 \pm 33$ , with a total citation density average of  $9 \pm 2$ . The 5-year citation count average was  $57 \pm 13$ , with a 5-year citation density average of  $11 \pm 3$ . Sanders et al<sup>23</sup> produced the article with the greatest total citation count (715), 5-year citation count (240), and 5-year citation density (48/year). Buckley et al<sup>7</sup> produced the article with the greatest total citation density (28/year). All 50 included articles were published more than 5 years ago. The most frequent level of evidence was IV, with 19 articles; levels of evidence III and I were the following most common, with 12 and 9 articles, respectively (Table 1). The majority of the articles were retrospective in nature (30), with the remaining articles consisting of 10 prospective studies, 8 general reviews, 1 systematic review, and 1 meta-analysis.

There was a strong correlation between total citation density and 5-year citation density ( $r = 0.930$ ,  $P < .001$ ). Total citation count was correlated strongly with 5-year citation density ( $r = 0.778$ ,  $P < .001$ ) and weakly correlated with total citation density ( $r = 0.618$ ,  $P < .001$ ). Years since publication had a weak negative correlation with total citation density ( $r = -0.469$ ,  $P = .001$ ) and no correlation with total citation count ( $r = 0.197$ ,  $P = .170$ ) (Figures 1 and 2). A 1-way analysis of variance found no differences between differing levels of evidence and total citation count ( $P = .599$ ), 5-year citation count ( $P = .456$ ), total citation density ( $P = .240$ ), or 5-year citation density ( $P = .456$ ). Full analytical information regarding citation count, citation density, and related levels of evidence may be found in Tables 1 and 2.

The year of publication for the 50 articles ranged from 1948 to 2014, with a median year of 1999. The years 1993 and 2000 produced the most articles with 11 and 4 articles, respectively. Within the cohort, the *Journal of Bone & Joint*

**Table 1.** Top 50 Articles of Calcaneus Fractures.

Articles	Citations (CD)	Citations in Last 5 y (CD)	Level of Evidence
Sanders R, Fortin P, DiPasquale T, Walling A. Operative treatment in 120 displaced intraarticular calcaneal fractures. Results using a prognostic computed tomography scan classification. <i>Clin Orthop Relat Res.</i> 1993;290:87-95.	715 (26)	240 (48)	IV
Buckley R, Tough S, McCormack R, et al. Operative compared with nonoperative treatment of displaced intra-articular calcaneal fractures: a prospective, randomized, controlled multicenter trial. <i>J Bone Joint Surg Am.</i> 2002;84(10):1733-1744.	503 (28)	208 (42)	I
Essex-Lopresti P. The mechanism, reduction technique, and results in fractures of the os calcis. <i>Br J Surg.</i> 1952;39(157):395-419.	460 (7)	103 (21)	IV
Sanders R. Displaced intra-articular fractures of the calcaneus. <i>J Bone Joint Surg Am.</i> 2000;82(2):225-250.	408 (20)	137 (27)	V
Zwipp H, Tscherne H, Thermann H, Weber T. Osteosynthesis of displaced intraarticular fractures of the calcaneus. Results in 123 cases. <i>Clin Orthop Relat Res.</i> 1993;290:76-86.	282 (10)	40 (8)	IV
Benirschke SK, Sangeorzan BJ. Extensive intraarticular fractures of the foot. Surgical management of calcaneal fractures. <i>Clin Orthop Relat Res.</i> 1993;292:128-134.	265 (10)	75 (15)	IV
Thordarson DB, Krieger LE. Operative vs. nonoperative treatment of intra-articular fractures of the calcaneus: a prospective randomized trial. <i>Foot Ankle Int.</i> 1996;17(1):2-9.	263 (11)	70 (14)	I
Folk JW, Starr AJ, Early JS. Early wound complications of operative treatment of calcaneus fractures: analysis of 190 fractures. <i>J Orthop Trauma.</i> 1999;13(5):369-372.	256 (12)	80 (16)	III
Sanders R. Intra-articular fractures of the calcaneus: present state of the art. <i>J Orthop Trauma.</i> 1992;6(2):252-265.	224 (8)	52 (10)	V
Abidi NA, Dhawan S, Gruen GS, Vogt MT, Conti SF. Wound-healing risk factors after open reduction and internal fixation of calcaneal fractures. <i>Foot Ankle Int.</i> 1998;19(12):856-861.	219 (10)	76 (15)	IV
Paley D, Hall H. Intra-articular fractures of the calcaneus. A critical analysis of results and prognostic factors. <i>J Bone Joint Surg Am.</i> 1993;75(3):342-354.	200 (7)	41 (8)	IV
Palmer I. The mechanism and treatment of fractures of the calcaneus; open reduction with the use of cancellous grafts. <i>J Bone Joint Surg Am.</i> 1948;30(1):2-8.	198 (3)	33 (7)	V
Rammelt S, Zwipp H. Calcaneus fractures: facts, controversies and recent developments. <i>Injury.</i> 2004;35(5):443-461.	178 (11)	75 (15)	V
Howard JL, Buckley R, McCormack R, et al. Complications following management of displaced intra-articular calcaneal fractures: a prospective randomized trial comparing open reduction internal fixation with nonoperative management. <i>J Orthop Trauma.</i> 2003;17(4):241-249.	177 (10)	66 (13)	I
Myerson M, Quill GE Jr. Late complications of fractures of the calcaneus. <i>J Bone Joint Surg Am.</i> 1993;75(3):331-341.	173 (6)	35 (7)	IV
Benirschke SK, Kramer PA. Wound healing complications in closed and open calcaneal fractures. <i>J Orthop Trauma.</i> 2004;18(1):1-6.	165 (10)	67 (13)	III
Stephenson JR. Treatment of displaced intra-articular fractures of the calcaneus using medial and lateral approaches, internal fixation, and early motion. <i>J Bone Joint Surg Am.</i> 1987;69(1):115-130.	164 (5)	14 (3)	IV
Griffin D, Parsons N, Shaw E, et al. Operative versus non-operative treatment for closed, displaced, intra-articular fractures of the calcaneus: randomised controlled trial. <i>BMJ.</i> 2014;349:g4483.	159 (27)	138 (28)	I
Letournel E. Open treatment of acute calcaneal fractures. <i>Clin Orthop Relat Res.</i> 1993;290:60-67.	154 (6)	26 (5)	IV
Harvey EJ, Grujic L, Early JS, Benirschke SK, Sangeorzan BJ. Morbidity associated with ORIF of intra-articular calcaneus fractures using a lateral approach. <i>Foot Ankle Int.</i> 2001;22(11):868-873.	150 (8)	46 (9)	III

(continued)

Table I. (continued)

Articles	Citations (CD)	Citations in Last 5 y (CD)	Level of Evidence
Crosby LA, Fitzgibbons T. Computerized tomography scanning of acute intra-articular fractures of the calcaneus. A new classification system. <i>J Bone Joint Surg Am.</i> 1990;72(6):852-859.	147 (5)	15 (3)	IV
Leung KS, Yuen KM, Chan WS. Operative treatment of displaced intra-articular fractures of the calcaneus. Medium-term results. <i>J Bone Joint Surg Br.</i> 1993;75(2):196-201.	146 (5)	27 (5)	III
Bèzes H, Massart P, Delvaux D, Fourquet JP, Tazi F. The operative treatment of intraarticular calcaneal fractures. Indications, technique, and results in 257 cases. <i>Clin Orthop Relat Res.</i> 1993;290:55-59.	143 (5)	12 (2)	IV
Rammelt S, Amlang M, Barthel S, Gavlik JM, Zwipp H. Percutaneous treatment of less severe intraarticular calcaneal fractures. <i>Clin Orthop Relat Res.</i> 2010;468(4):983-990.	139 (14)	86 (17)	IV
Stulik J, Stehlik J, Rysavy M, Wozniak A. Minimally-invasive treatment of intra-articular fractures of the calcaneus. <i>J Bone Joint Surg Br.</i> 2006;88(12):1634-1641.	132 (9)	65 (13)	IV
Parmar HV, Triffitt PD, Gregg PJ. Intra-articular fractures of the calcaneum treated operatively or conservatively. A prospective study. <i>J Bone Joint Surg Br.</i> 1993;75(6):932-937.	131 (5)	23 (5)	I
Pozo JL, Kirwan EO, Jackson AM. The long-term results of conservative management of severely displaced fractures of the calcaneus. <i>J Bone Joint Surg Br.</i> 1984;66(3):386-390.	129 (4)	20 (4)	IV
Randle JA, Kreder HJ, Stephen D, Williams J, Jaglal S, Hu R. Should calcaneal fractures be treated surgically? A meta-analysis. <i>Clin Orthop Relat Res.</i> 2000;377:217-227.	128 (6)	25 (5)	III
Kline AJ, Anderson RB, Davis WH, Jones CP, Cohen BE. Minimally invasive technique versus an extensile lateral approach for intra-articular calcaneal fractures. <i>Foot Ankle Int.</i> 2013;34(6):773-780.	126 (18)	101 (20)	III
Lim EV, Leung JP. Complications of intraarticular calcaneal fractures. <i>Clin Orthop Relat Res.</i> 2001;(391):7-16.	124 (7)	45 (9)	III
Schildhauer TA, Bauer TW, Josten C, Muhr G. Open reduction and augmentation of internal fixation with an injectable skeletal cement for the treatment of complex calcaneal fractures. <i>J Orthop Trauma.</i> 2000;14(5):309-317.	123 (6)	15 (3)	II
Weber M, Lehmann O, Sägesser D, Krause F. Limited open reduction and internal fixation of displaced intra-articular fractures of the calcaneus. <i>J Bone Joint Surg Br.</i> 2008;90(12):1608-1616.	121 (10)	74 (15)	III
Loucks C, Buckley R. Bohler's angle: correlation with outcome in displaced intra-articular calcaneal fractures. <i>J Orthop Trauma.</i> 1999;13(8):554-558.	119 (6)	35 (7)	I
Zwipp H, Rammelt S, Barthel S. Calcaneal fractures—open reduction and internal fixation (ORIF). <i>Injury.</i> 2004;35(Suppl 2):SB46-SB54.	117 (7)	50 (10)	V
Buckley RE, Meek RN. Comparison of open versus closed reduction of intraarticular calcaneal fractures: a matched cohort in workmen. <i>J Orthop Trauma.</i> 1992;6(2):216-222.	115 (4)	14 (3)	III
Flemister AS Jr, Infante AF, Sanders RW, Walling AK. Subtalar arthrodesis for complications of intra-articular calcaneal fractures. <i>Foot Ankle Int.</i> 2000;21(5):392-399.	113 (6)	36 (7)	III
Eastwood DM, Langkamer VG, Atkins RM. Intra-articular fractures of the calcaneus. Part II: Open reduction and internal fixation by the extended lateral transcaneal approach. <i>J Bone Joint Surg Br.</i> 1993;75(2):189-195.	113 (4)	19 (4)	IV
DeWall M, Henderson CE, McKinley TO, Phelps T, Dolan L, Marsh JL. Percutaneous reduction and fixation of displaced intra-articular calcaneus fractures. <i>J Orthop Trauma.</i> 2010;24(8):466-472.	112 (11)	72 (14)	III
Csizy M, Buckley R, Tough S, et al. Displaced intra-articular calcaneal fractures: variables predicting late subtalar fusion. <i>J Orthop Trauma.</i> 2003;17(2):106-112.	112 (7)	37 (7)	I

(continued)

**Table 1. (continued)**

Articles	Citations (CD)	Citations in Last 5 y (CD)	Level of Evidence
Burdeaux BD. Reduction of calcaneal fractures by the McReynolds medial approach technique and its experimental basis. <i>Clin Orthop Relat Res.</i> 1983;177:87-103.	112 (3)	10 (2)	V
Soeur R, Remy R. Fractures of the calcaneus with displacement of the thalamic portion. <i>J Bone Joint Surg Br.</i> 1975;57(4):413-421.	112 (2)	14 (3)	IV
Radnay CS, Clare MP, Sanders RW. Subtalar fusion after displaced intra-articular calcaneal fractures: does initial operative treatment matter? <i>J Bone Joint Surg Am.</i> 2009;91(3):541-546.	111 (10)	51 (10)	III
Agren PH, Wretenberg P, Sayed-Noor AS. Operative versus nonoperative treatment of displaced intra-articular calcaneal fractures: a prospective, randomized, controlled multicenter trial. <i>J Bone Joint Surg Am.</i> 2013;95(15):1351-1357.	110 (16)	88 (18)	I
Ibrahim T, Rowsell M, Rennie W, Brown AR, Taylor GJ, Gregg PJ. Displaced intra-articular calcaneal fractures: 15-year follow-up of a randomised controlled trial of conservative versus operative treatment. <i>Injury.</i> 2007;38(7):848-855.	110 (8)	60 (12)	I
Potter MQ, Nunley JA. Long-term functional outcomes after operative treatment for intra-articular fractures of the calcaneus. <i>J Bone Joint Surg Am.</i> 2009;91(8):1854-1860.	109 (10)	59 (12)	IV
Heier KA, Infante AF, Walling AK, Sanders RW. Open fractures of the calcaneus: soft-tissue injury determines outcome. <i>J Bone Joint Surg Am.</i> 2003;85(12):2276-2282.	108 (6)	30 (6)	II
Myerson M, Manoli A. Compartment syndromes of the foot after calcaneal fractures. <i>Clin Orthop Relat Res.</i> 1993;(290):142-150.	108 (4)	16 (3)	V
Broden B. Roentgen examination of the subtaloid joint in fractures of the calcaneus. <i>Acta Radiol.</i> 1949;31(1):85-91.	107 (2)	16 (3)	V
Mitchell MJ, McKinley JC, Robinson CM. The epidemiology of calcaneal fractures. <i>Foot (Edinb).</i> 2009;19(4):197-200.	104 (9)	86 (17)	IV
Kitaoka HB, Schaap EJ, Chao EY, An KN. Displaced intra-articular fractures of the calcaneus treated non-operatively. Clinical results and analysis of motion and ground-reaction and temporal forces. <i>J Bone Joint Surg Am.</i> 1994;76(10):1531-1540.	103 (4)	23 (5)	IV
Averages	178±33 (9±2)	57±13 (11±3)	

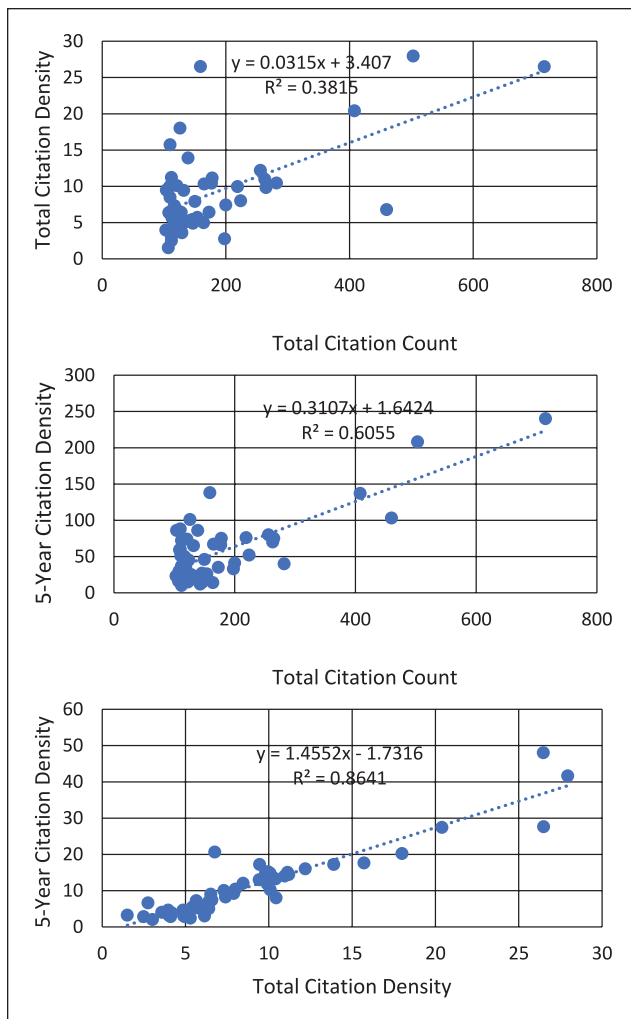
*Surgery—American* produced the most articles with 11. *Clinical Orthopaedics and Related Research* and the *Journal of Orthopaedic Trauma* were the next most productive journals, with 10 and 9 included articles, respectively.

Thirty-four articles originated from within the United States. Seven articles originated from the United Kingdom, whereas Canada produced 6 articles and Germany produced 5. The most productive institutions were Florida Orthopaedic Institute with 5 articles, and Harborview Medical Center and Foothills Medical Centre, Calgary, with 3 articles each. Roy W. Sanders was the most productive author in the field, authoring 6 articles, with 3 as the lead author. He accumulated 1679 total citations and obtained a weighted citation score of 169 (Table 3). Roy W. Sanders also had the largest Scopus h-index score of 56. The next 4 most productive authors—Richard E. Buckley, Hans Zwipp, Stephen K. Benirschke, and Stefan Rammelt—each produced 2 first

author articles. Further information regarding the most highly cited authors may be found in Table 3.

## Discussion

This study sought to conduct a citation analysis of the 50 highest cited articles within the calcaneus fracture literature in an effort to illuminate trends within the current management of calcaneus fractures and highlight the most influential articles and authors. Calcaneus fractures have historically been viewed as a complex fracture to treat, leading to a myriad of proposed classifications, imaging methods, reduction goals and techniques, as well as fixation strategies throughout the literature.<sup>3</sup> Many of the highest cited articles from prior decades still have relatively high 5-year citation counts, emphasizing the continued relevance of these landmark articles and highlighting a need

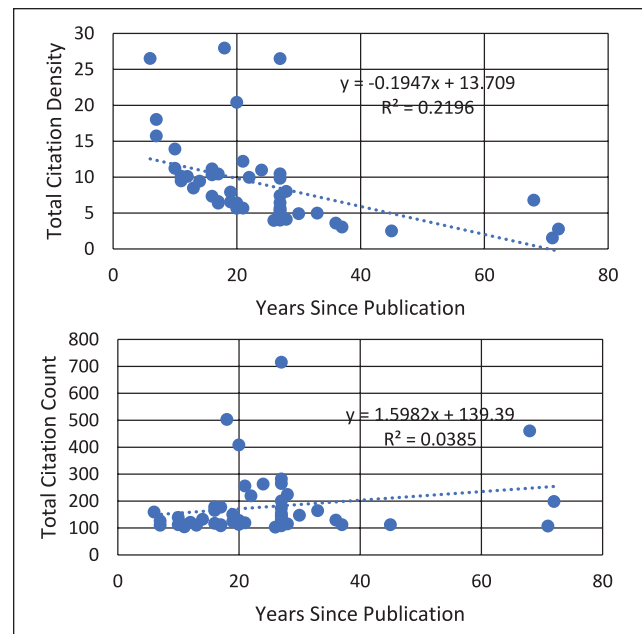


**Figure 1.** Pearson's Correlations for Total Citation Density vs Total Citation Count, 5-Year Citation Density vs Total Citation Count, and 5-Year Citation Density vs Total Citation Density.

for more recent and robust high level evidence regarding calcaneus fractures.

Analyzing the most cited articles reveals that studies exploring outcomes related to operative methods make up a substantial portion of the influential literature. There were 31 articles focusing primarily on patient outcomes following specific treatments—specifically with 14 articles assessing treatment with ORIF, 2 articles evaluating conservative treatment alone, 10 articles comparing operative vs nonoperative management, and 5 articles specifically addressing the implementation of minimally invasive techniques. Among the remaining articles, 8 articles focused on risk factors predicting complications following calcaneus fracture treatment and 5 articles offered a general review regarding calcaneus fracture management.

Roy W. Sanders has significantly impacted the calcaneus fracture literature with 6 published articles in the top



**Figure 2.** Pearson's Correlations for Total Citation Density vs Years Since Publication and Total Citation Count vs Years Since Publication.

50, 3 of which are first authorships. All 3 of his first authorship articles are within the top 10 most cited articles. The earliest of the 3 articles, titled “Intra-articular Fractures of the Calcaneus: Present State of the Art,” highlights the lack of consensus regarding classification, type of operation, or postoperative management regarding calcaneus fractures in 1992.<sup>22</sup> Sanders focused on the shortcomings of classifications at that time, which all relied on radiographic techniques, and the associated limitations of evaluating the calcaneus with plain films alone. Because of this, he stated all previous calcaneus fracture literature was ambiguous at best. To address this, Sanders proposed a computed tomographic scan classification system based on the location and number of articular fracture fragments. The Sanders classification is still the most commonly used classification system today and is one of the most predictive of clinical outcomes.<sup>20,24,26</sup>

One year later, Sanders published “Operative Treatment in 120 Displaced Intraarticular Calcaneal Fractures. Results Using a Prognostic Computed Tomography Scan Classification,” which is the most cited article in the cohort.<sup>23</sup> Sanders meticulously applied his classification system and displayed the increasing complications and treatment difficulties with higher fracture classes (ie, more articular comminution). Interestingly, Sanders also documented a steep learning curve in which excellent and good outcomes increased from 27% to 84% over a 4-year period of conducting operations. Sanders’ final first author article in the cohort was published in 2000 and

**Table 2.** Average Citation Count and Density for Each Level of Evidence.

Level of Evidence (Total Count)	Total Citation Count	5-y Citation Count	Total Citation Density	5-y Citation Density
Level I (9)	197±99	81±45	13.0±6.7	16.1±9.0
Level II (2)	115±95	23±95	6.3±1.3	4.5±19.1
Level III (12)	139±26	53±16	9.0±2.4	10.6±3.3
Level IV (19)	203±73	55±26	8.2±2.6	11.0±5.2
Level V (8)	182±86	49±35	7.3±5.2	9.7±7.0

**Table 3.** The Most Highly Cited Authors.

Author	Number of Articles in the Cohort (Number of First Author Appearances)	Total Citations	Weighted Citation Points	Scopus h-index
Sanders, R. (Tampa, FL)	6 (3)	1,679	168	56
Buckley, R. (Calgary, Canada)	5 (2)	1,026	132	34
Zwipp, H. (Hannover, Germany)	4 (2)	716	128	42
Benirschke, S.K. (Seattle, WA)	3 (2)	580	111	27
Rammelt, S. (Dresden, Germany)	3 (2)	434	82	42
Walling, A. (Tampa, FL)	3 (0)	936	70	19
McCormack, R. (Calgary, Canada)	3 (0)	792	98	30
Pate, G. (Calgary, Canada)	3 (0)	792	98	10
Leighton, R. (Calgary, Canada)	3 (0)	792	98	32
Petrie, D. (Calgary, Canada)	3 (0)	792	98	16
Galpin, R. (Calgary, Canada)	3 (0)	792	98	18

offered an updated current concepts review.<sup>21</sup> He displayed a shift in focus from classification to surgical treatment methods, in which he favored ORIF using an extensile lateral approach, lag-screw fixation of the joint, and plate fixation of the calcaneal body. This focus on finding ideal operative methods continues today with novel ideas such as minimally invasive approaches.

Considering that the 50 analyzed articles were published over a range of 66 years, it is notable that 11 (22%) articles were published in 1993 alone. This suggests a transformative time in understanding and managing of calcaneus fractures as reflected in the literature. Advancements in understanding the fracture pattern, access to computed tomographic scanning, and updated surgical techniques shortly prior to 1993 may be responsible for the explosion.<sup>2</sup> It is important to consider that 24 (48%) of the analyzed articles were published in 2000 or later, indicating that there is continued focus and advancements within the influential calcaneus fracture literature. Interestingly, level of evidence was not found to be correlated with any measure of article citation count, which is incongruent with other citation analysis.<sup>8,19</sup> The findings that the most articles were produced within the United States and published in the *Journal of Bone & Joint Surgery–American Volume* matches past foot and ankle-related citation analyses.<sup>16,19</sup>

There are inherent limitations to our study. First, total citation count alone may not fully encapsulate the impact of

an article, which means influential articles may have been left out of the study. In an effort to address this, 5-year citation density was used to highlight influential recent articles that may have had less time to accumulate high citation counts.<sup>5</sup> A second limitation is that the subjective nature of several analysis steps, such as article inclusion and determining level of evidence, allows an increased opportunity for bias. Finally, we did not weigh author contribution when assessing the most productive authors, which is a consideration for future citation analysis within orthopaedics.

This study successfully analyzes and presents the characteristics among the highest-cited articles related to calcaneus fractures. Therapeutic studies analyzing outcomes represented a majority of the articles, specifically after ORIF, and 22% of all included articles were published in 1993. The *Journal of Bone & Joint Surgery–American Volume* published the most included articles, and the article level of evidence showed no impact on the included measures of an article's influence. The information presented highlights the most influential works and authors within the field and may offer guidance for future authors hoping to contribute to the calcaneus fracture literature.

### Ethical Approval

Ethical approval was not sought for the present study because all the collected and analyzed information was gained from publicly available data.

## Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. ICMJE forms for all authors are available online.

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Bennet A. Butler, MD,  <https://orcid.org/0000-0002-2725-4057>

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