Tibial Plafond Fractures: Analysis of the 50 Most Cited Articles

Franklin J. Powlan MD[1,2], Michael M. Polmear MD[1,2], John P. Scanaliato MD[1,2], Tyler Kastner BS[2], John C. Dunn MD[1,2]

1) William Beaumont Army Medical Center, Ft. Bliss, TX

2) Texas Tech University Health Science Center, El Paso, TX

Objectives: To determine the characteristics and trends of the 50 most cited articles regarding tibial plafond fractures

Main outcome measurement: Citations, journal, level of evidence, study focus, and study design.

Methods: ISI Web of Science with specific article review.

Results: Identified studies had 53 – 324 total citations. The majority were published in the Journal of Orthopaedic Trauma (35%). Retrospective studies were the most common (88%), with retrospective case series being the most common design (57%). Level IV evidence was the most common (61%), and there were no Level I studies.

Conclusion: Therapeutic retrospective case series describing soft tissue management and staged fixation continue to be the most cited articles in the care of tibial plafond fractures.

Level of Evidence: IV

Keywords: Bibliometric, Citation density, Fracture, Lower extremity trauma, Pilon, Tibial plafond, Trauma

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INTRODUCTION

Tibial plafond fractures, or pilon fractures, are challenging, morbid injuries with variable management approach based on comorbidities, functional status, soft tissue considerations, polytrauma, and fracture pattern.[1] A wide body of literature has emerged on biomechanics, fixation techniques, acute complications, and long-term sequelae of pilon fractures.

The study design used in modern literature publications included review articles, case series, cohorts, technique guides, and biomechanical studies, each discussing diagnostic, prognostic, or therapeutic topics with variable levels of evidence.[24] Citation density of an article, defined as citations per year, is a function of the quality of evidence, journal ranking, author expertise, and institution reputation[1-4]. Within orthopaedic surgery, bibliometric citation density studies have been performed on the most cited articles in orthopaedic surgery, pediatric orthopaedics, distal radius fractures, acetabular fractures, and foot and ankle surgery.[2-19] Citation density for a given article indicates usage, technical advances, influence on other studies, and quality of findings while multiple articles elucidate trends in management and influence on future studies. The purpose of the study was to analyze the bibliometric characteristics of the 50 most-cited articles in the tibial plafond fracture literature.

METHODS

A literature search was performed on the ISI Web of Science database (accessed 21 January 2021, www.webofscience.com) for the terms “pilon fracture” and “tibial plafond fracture”. Articles from all orthopaedic journals and years in the ISI Web of Science database were included in the search. A total of 1207 articles were identified, which were sorted by the total number of citations. The abstracts and full texts of the most cited 60 articles were independently reviewed by two authors to determine their relevance to tibial plafond fractures. One article with a citation count among the highest 50 articles from the initial search was excluded due to subject matter outside of tibial plafond fractures. An additional article was included due to an equal number of citations as the fiftieth article. Citation density was calculated for each article.

The following information was tabulated: number of citations, year of publication, journal of publication, authors, number of authors, citation density (citations per years since publication date), study type, and level of evidence. Study types were determined to be basic science or clinical research. Both basic science and clinical articles were then subtyped and further stratified by level of evidence. The level of evidence indicated in the article was corroborated or independently determined by two authors using the level of evidence guideline from The Journal of Joint and Bone Surgery, American Volume.[20] Any discrepancy between the reviewers was resolved by consensus.

Citation density among the various study types in the included articles was compared. The solitary biomechanical

and technique papers were excluded from this analysis. Data normality was assessed using the Shapiro-Wilk test. Variance was assessed using the Kruskall-Wallis test for non-parametric data. Post-hoc analysis was performed using a two-sided Mann-Whitney U test with Bonferroni correction. Median differences were determined by Hodges-Lehman's estimation. Linear associations were assessed with Spearman's rank correlation.

RESULTS

The bibliometric analysis yielded 51 articles with the highest number of citations in the tibial plafond literature, as the last two articles had an equal number of citations (Appendix A). The citation count ranged from 53 to 324, and articles were published between 1983 and 2013. Citation density ranged from 1.9 to 32.4 with median and interquartile values of 5.14 and 4.4, respectively.

Articles were classified by study design, level of evidence, journal of publication, and publication date to delineate trends in citation density. The highest frequency of articles for a given journal was published in the Journal of Orthopaedic Trauma (35%) which had an IF of 1.65 and SJR of 1.02. (Table 1). No significant difference was found in median citation density for journals published after post-hoc Mann-Whitney U analysis with Bonferroni correction ($p>0.00179$). No significant difference was found in either median citation density with IF and SJR with Spearman rank correlation (Table 1).

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Articles were also stratified as diagnostic, prognostic, and therapeutic (Table 2). Therapeutic was the most frequently cited study subtype (29/51, 57%, median citation density 4.79), whereas prognostic studies had the highest median citation density (16/51, 31%, median citation density 5.94). Kruskal-Wallis test was significant ($p<0.0001$), but there were no significant differences in median citation densities among the study foci after post-hoc Mann-Whitney U analysis with Bonferroni correction ($p>0.00833$).

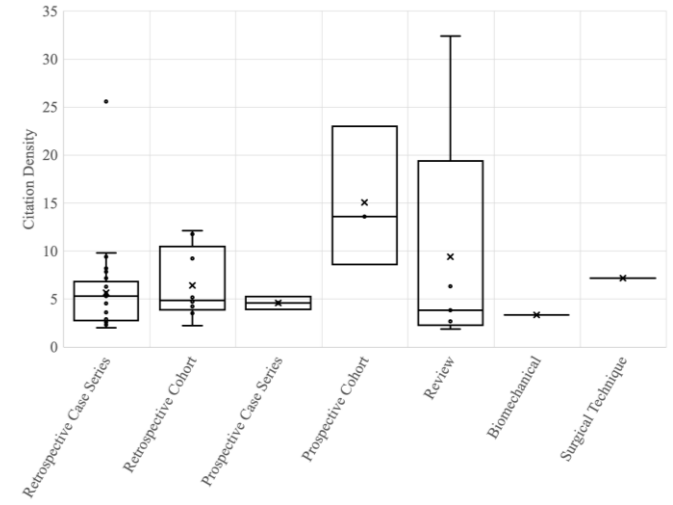
There were seven study designs among the included articles: biomechanical review, prospective case series, retrospective case series, prospective cohorts, retrospective cohorts, reviews, and surgical technique (Figure 1). Prospective cohorts had the highest median citation density at

Table 1: Journals publishing on tibial plafond fractures with citation density and most recent journal metrics.

Journal of Publication	N Articles	Citation Density				IF 2019†	SJR 2019‡
		Median*	IQR	Min	Max		
J Orthop Res	1	32.4	0.0	32.4	32.4	2.86	1.022
Int Orthop	1	7.18	0.0	7.2	7.2	2.957	1.533
J Bone Joint Surg Br	2	6.53	1.7	4.9	8.2	4.525	2.375
J Bone Joint Surg Am	7	6.27	1.8	4.6	8.6	4.631	2.482
J Orthop Trauma	18	5.41	5.3	2.2	23.0	1.645	1.023
J Am Acad Orthop Surg	2	5.08	1.3	3.8	6.3	2.366	1.297
Clin Orthop Relat Res	7	4.79	3.9	2.3	25.6	2.443	1.487
J Trauma	4	3.80	4.2	2.5	13.6	3.41	1.598
INJURY	3	3.63	1.9	2.0	5.8	2.291	0.904
J Biomech Eng	1	3.32	0.0	3.3	3.3	1.904	0.683
Foot Ankle Int	5	3.06	1.0	2.4	3.6	2.721	1.487
Orthop Clin North Am	1	1.85	0.0	1.9	1.9	2.426	1.082
Total	*51*	*5.14*	*4.4*	*1.9*	*32.4*	*2.582*	*1.392*

*Kruskal-Wallis test was significant ($p=0.0126$), but there were no significant differences in median citation densities after post-hoc analysis ($p>0.00179$).
†Spearman rank correlation was not significant between median citation density and impact factor (†, $p=0.138$) or SCImago Journal Rank (‡, $p=0.307$)

Figure 1. Box-and-whisker plots for citation density by study type.



There were seven study designs among the included articles: biomechanical review, prospective case series, retrospective case series, prospective cohorts, retrospective cohorts, reviews, and surgical technique (Figure 1). Prospective cohorts had the highest median citation density at 13.6 with retrospective case series constituting most of the studies at 61% (29 of 51) (Table 2). The majority (45/51, 88%) of articles were retrospective studies. Prospective studies had a higher median citation density compared to retrospective studies, 6.93 vs 4.86, respectively. Kruskal-Wallis test was significant ($p<0.0001$), but there were no significant differences in median citation densities among the study timelines after post-hoc Mann-Whitney U analysis with Bonferroni correction ($p>0.05$) (Table 2).

The most frequently cited articles were level IV evidence (31/51, 61%, median citation density 4.79) while level II evidence articles had the highest citation density (3/51, 6%, median citation density 13.6). Kruskal-Wallis test was significant ($p=0.00831$), but there were no significant differences in median citation densities among the levels of evidence after post-hoc Mann-Whitney U analysis with Bonferroni correction ($p>0.00833$) (Table 2).

Most cited articles were published in the 1990s (21/51, 41%, median citation density 3.63) while articles published in the 2010s had the highest median citation density (8/51, 16%, median citation density 7.18). Kruskal-Wallis test was significant ($p<0.001$), and there was a significant difference in median citation densities between articles published in the 1990s versus 2010s by Mann-Whitney U analysis of 3.95 (95% confidence interval 2.04-7.41, $p=0.00269$) with Bonferroni correction ($p<0.00833$) (Table 3).

Table 2. Study Characteristic citation density analysis.

Study	N Articles	Citation Density			
		Median	IQR	Min	Max
*Level of Evidence**					
II	3	13.6	7.2	8.6	23
III	9	4.86	5.0	2.2	12.1
IV	31	4.79	3.5	2.0	25.6
V	8	4.71	3.4	1.9	32.4
*Study Design**					
Prospective Cohort	3	13.6	7.2	8.6	23.0
Surgical Technique	1	7.18	0	7.2	7.2
Retrospective Case Series	29	5.31	3.6	2.0	25.6
Retrospective Cohort	9	4.86	5.0	2.2	12.1
Prospective Case Series	3	4.58	0.7	3.9	5.3
Review	5	3.82	3.7	1.9	32.4
Biomechanical	1	3.32	0	3.3	3.3
*Study Timeline**					
Prospective	6	6.93	7.6	3.9	23.0
Retrospective	45	4.86	4.3	1.9	32.4
*Study Focus**					
Diagnostic	6	4.34	4.7	2.6	9.4
Prognostic	16	5.94	4.6	2.3	32.4
Therapeutic	29	4.79	2.8	1.9	23.0
Total	*51*	*5.14*	*4.4*	*1.9*	*32.4*

*Kruskal-Wallis test was significant, but there were no significant differences in median citation densities after post-hoc. IQR: interquartile range

DISCUSSION

The top 50 articles on pilon fractures shared common threads with other orthopaedic bibliometric studies. We found most of the articles were considered level IV evidence, were retrospective, and there was a higher citation density of more recently published articles. This study enumerated the origins of information used today for understanding and managing pilon fractures, providing foundational knowledge for surgeons and trainees.

Table 3: Citation Density based on Publication Decade.

Study Publication Decade	N Articles	Citation Density			
		Median*	IQR	Min	Max
1980	4	2.69	1.1	1.9	5.1
1990	21	3.63	2.2	2.0	12.1
2000	18	5.63	3.5	2.7	25.6
2010	8	7.18	6.5	5.6	32.4
Total	*51*	*5.14*	*4.4*	*1.9*	*32.4*

**Kruskal-Wallis test was significant (p<0.001), and there was a significant difference in median citation densities between 1990 and 2010 (p=0.00269). IQR: interquartile range*

The article with the highest citations and citation density of 32.4 was by Anderson et al and discussed post-traumatic arthritis.[25] Of the top 50 cited articles only two other articles had a citation density greater than 20, Etiology of Ankle Osteoarthritis by Valderrabano et al and Incisional Negative Pressure Wound Therapy After High-Risk Lower Extremity Trauma by Stannard et al.[26,27] These articles discussed the etiology of ankle osteoarthritis and negative pressure wound therapy after high-risk lower extremity injuries, respectively. All three of these articles discussed lower extremity injury or soft tissue handling topics. The clear titles, broadness of the study topics, and applicability outside of pilon fractures, which account for less than 7% of tibial fractures, likely led to higher citation rates and densities.[1,23]

Of the top 50 articles, most articles were level IV evidence and none of the articles were level I evidence. This trend mirrors other orthopaedic citation rank bibliometric studies as retrospective case series addressing specific surgical and clinical questions while level I studies require prospective, randomized, controlled trials that are difficult to execute in trauma populations.[3,9,11,13-16,23,24] This study found that retrospective case series addressing specific clinical and surgical outcomes were important cornerstones in tibial plafond management.

Overall, retrospective case series were the most commonly cited type of journal article (28/51, 55%), which was similar to other orthopaedic bibliometric studies.[2-4, 9-12, 15, 16, 22, 23] Case series were typically lower cost, performed at single institutions, and were completed over a shorter period of time than prospective trials.

While most of the articles were published in the 1990s (21/51, 41%) and 2000s (18/51, 35%), the articles published in the 2010s (8/51, 16%) had a significantly higher citation density suggesting the importance of recency of publications, a similar finding to Jones et al and Baldwin et al in shoulder, pediatric, and cartilage surgery. However, most therapeutic studies discussing surgical management of pilon fractures were published prior to 2000, with the most cited article being published in 1999 by Sirkin et al. which discusses using a staged protocol for soft tissue management.[28]

CONCLUSION

This list of the top 50 cited articles discussing pilon fractures contains myriad study types, foci, and study designs, reflecting the body of literature on this challenging injury, including diagnosis, staging, and sequelae. The number of citations and citation density were indicators of influence but did not necessarily assess the quality of the study design or the strength of conclusions. Despite these limitations, these articles were foundational in elucidating historical treatments, guiding surgical decision-making, and revealing gaps in knowledge for further research opportunities.

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Appendix A: Top 50 Tibial Plafond Articles by Citation

Rank	Author	Year	Journal	Title	Total Citations	Citation Density	LOE
1	Anderson DD	2011	J Orthop Res	Post-traumatic osteoarthritis: improved understanding and opportunities for early intervention	324	32.4	5
2	Valderrabano V	2009	Clin Orthop Relat Res	Etiology of ankle osteoarthritis	307	25.6	4
3	Sirkin M	1999	J Orthop Trauma	A staged protocol for soft tissue management in the treatment of complex pilon fractures	266	12.1	3
4	Teeny SM	1993	Clin Orthop Relat Res	Open reduction and internal-fixation of tibial plafond fractures - variables contributing to poor results and complications	220	7.9	4
5	Wyrsch B	1996	J Bone Joint Surg Am	Two-staged delayed open reduction and internal fixation of severe pilon fractures	215	9.8	4
5	Patterson MJ	1999	J Orthop Trauma	Operative treatment of fractures of the tibial plafond - a randomized prospective study	215	8.6	2
7	Stannard JP	2012	J Orthop Trauma	Incisional negative pressure wound therapy after high-risk lower extremity fractures	207	23	2
8	Stannard JP	2006	J Trauma	Negative pressure wound therapy to treat hematomas and surgical incisions following high-energy trauma	204	13.6	2
9	Blauth M	2001	J Orthop Trauma	Surgical options for the treatment of severe tibial pilon fractures: a study of three techniques	184	9.2	3
10	Ovadia DN	1986	J Bone Joint Surg Am	Fractures of the tibial plafond	180	5.1	3
11	Tornetta P	1993	J Orthop Trauma	Pilon fractures - treatment with combined internal and external fixation	147	5.3	4
12	Pollak AN	2003	J Bone Joint Surg Am	Posttraumatic ankle osteoarthritis after ankle-related fractures	141	11.8	3
12	Horisberger M	2009	J Orthop Trauma	Outcomes after treatment of high-energy tibial plafond fractures	141	7.8	4
14	Bone, L	1993	Clin Orthop Relat Res	External fixation of severely comminuted and open tibial pilon fractures	134	4.8	4
15	Topliss CJ	2005	J Bone Joint Surg Br	Anatomy of pilon fractures of the distal tibia	131	8.2	4
16	Marsh JL	1995	J Bone Joint Surg Am	Use of an articulated external fixator for fractures of the tibial plafond	119	4.6	4
17	Marsh JL	2003	J Bone Joint Surg Am	Tibial plafond fractures - how do these ankles function over time?	116	6.4	4
18	Watson JT	2000	Clin Orthop Relat Res	Pilon fractures - treatment protocol based on severity of soft tissue injury	114	5.4	4
19	Bourne RB	1983	J Trauma	Intra-articular fractures of the distal tibia - the pilon fracture	109	2.9	4
20	Pugh KJ	1999	J Trauma	Tibial pilon fractures: a comparison of treatment methods	104	4.7	3
21	Moore TJ	1995	Foot Ankle Int	Early outcome of hybrid external fixation for fracture of the distal tibia	93	4.2	3
21	Anglen JO	1999	J Orthop Trauma	Retrograde intramedullary nailing for ankle arthrodesis	93	3.6	4
23	Hutson JJ	1998	J Orthop Trauma	Infections in periarticular fractures of the lower extremity treated with tensioned wire hybrid fixators	90	3.9	4
24	Dillin L	1986	J Trauma	Delayed wound-healing, infection, and nonunion following open reduction and internal-fixation of tibial plafond fractures	88	2.5	4

25	Helfet DL	1997	INJURY	Minimally invasive plate osteosynthesis of distal fractures of the tibia	87	3.6	4
26	Richter M	2005	J Orthop Trauma	Intraoperative three-dimensional imaging with a motorized mobile c-arm (SIREMOBIL ISO-C-3D) in foot and ankle trauma care - a preliminary report	85	5.3	4
27	Atesok K	2007	INJURY	The use of intraoperative three-dimensional imaging (iso-c-3d) in fixation of intraarticular fractures	81	5.8	4
28	Amorosa LF	2010	J Orthop Trauma	Distal tibia fractures: management and complications of 101 cases	79	7.2	4
28	Joveniaux P	2010	Int Orthop	A surgical approach to posterior pilon fractures	79	7.2	5
30	Grose A	2007	J Orthop Trauma	Open reduction and internal fixation of tibial pilon fractures using a lateral approach	77	5.5	4
31	Cole PA	2013	J Orthop Trauma	The pilon map: fracture lines and comminution zones in ota/ao type 43c3 pilon fractures	75	9.4	4
32	Bonar SK	1993	Foot Ankle Int (prev Foot & Ankle)	Unilateral external fixation for severe pilon fractures	73	2.6	4
32	Tornetta P	1996	Clin Orthop Relat Res	Axial computed tomography of pilon fractures	73	2.9	4
34	Helfet DL	1994	Clin Orthop Relat Res	Intraarticular pilon fracture of the tibia	69	2.6	4
34	Martin JS	1997	J Orthop Trauma	Outcome following open reduction and internal fixation of open pilon fractures	69	6.3	4
34	Buechler L	2009	J Orthop Trauma	Assessment of the ao/asif fracture classification for the distal tibia	69	2.9	4
34	Boraiah S	2010	J Bone Joint Surg Am	Reliability of radiologic assessment of the fracture anatomy at the posterior tibial plafond in malleolar fractures	69	5.8	4
38	Bhattacharyya T	2006	J Orthop Trauma	Rhbmp-7 accelerates the healing in distal tibial fractures treated by external fixation	68	4.9	3
38	Ristiniemi J	2007	J Bone Joint Surg Br	Complications associated with the posterolateral approach for pilon fractures	68	4.5	4
40	Dirschl DR	2004	J Am Acad Orthop Surg	Articular fractures	65	3.8	5
41	Bone LB	1987	Orthop Clin North Am	Fractures of the tibial plafond - the pilon fracture	63	1.9	5
41	Funk JR	2002	J Biomech Eng	The axial injury tolerance of the human foot/ankle complex and the effect of achilles tension	63	3.3	5
43	Swiontkowski MF	1997	J Orthop Trauma	Interobserver variation in the ao/ota fracture classification system for pilon fractures: is there a problem?	62	2.6	4
44	Saleh M	1993	INJURY	Early weight bearing after lower extremity fractures in adults	57	6.3	5
44	Kubiak EN	2013	J Am Acad Orthop Surg	Intraarticular fractures of the distal tibia - surgical-management by limited internal-fixation and articulated distraction	57	2	4
46	Harris AM	2006	Foot Ankle Int	Results and outcomes after operative treatment of high-energy tibial plafond fractures	56	3.5	3
46	Smith MV	2012	J Bone Joint Surg Am	Lower extremity-specific measure of disability and outcomes in orthopaedic surgery	56	5.6	5

48	Sands A	1998	Clin Orthop Relat Res	Clinical and functional outcomes of internal fixation of displaced pilon fractures	55	2.3	4
49	DeCoster TA	1999	Foot Ankle Int	Rank order analysis of tibial plafond fractures: does injury or reduction predict outcome?	54	2.4	4
50	Williams TM	1998	J Orthop Trauma	Temporary external fixation for the management of complex intra- and periarticular fractures of the lower extremity	53	2.7	5
50	Haidukewych GJ	2002	J Orthop Trauma	External fixation of tibial plafond fractures: is routine plating of the fibula necessary?	53	2.2	3

Clin Orthop Relat Res: Clinical Orthopaedics and Related Research

Foot Ankle Int: Foot & Ankle International, previously Foot & Ankle

INJURY: Injury-International Journal of the Care of the Injured

Int Orthop: International Orthopaedics

J Am Acad Orthop Surg: Journal of the American Academy of Orthopaedic Surgeons

J Biomech Eng: Journal of Biomechanical Engineering – Transactions of the ASME

J Bone Joint Surg Am: Journal of Bone and Joint Surgery – American Volume

J Bone Joint Surg Br: Journal of Bone and Joint Surgery – British Volume

J Orthop Res: Journal of Orthopaedic Research

J Orthop Trauma: Journal of orthopaedic trauma

J Trauma: Journal of Trauma-Injury Infection and Critical Care

LOE: Level of Evidence

Orthop Clin North Am: Orthopedic Clinics of North America

