

The Fifty Most-Cited Articles Regarding SLAP Lesions



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Purpose: To identify and evaluate the top 50 most-cited articles pertaining to SLAP tears. **Methods:** The ISI Web of Knowledge database was used to conduct a query for articles pertaining to SLAP tears. Our query was conducted in April 2020 with multiple Boolean operative combinations performed by 2 independent reviewers. Articles on the final list were further reviewed to extract the following data: manuscript title, first author, total citation count, year of publication, citation density since publication, current citation rate since 2013, journal, country of origin, and level of evidence. **Results:** Our initial search yielded 2,597 articles. Within this cohort, the top 50 publications pertaining to SLAP tears were identified that met our search criteria. The top article was cited 802 times while the 50th ranked article was cited 46 times. The average number of citations per publication was 131, whereas the average citation density since year of publication was 7.3. No strong correlations were found between citation density and year published. Twelve journals published articles pertaining to SLAP tears, with *Arthroscopy* accounting for the greatest number (15 articles, 30%). Most articles were graded with a level of evidence (LOE) of IV (n = 24, 48%), followed by review articles without LOE (n = 8, 16%). Only 2 articles achieved an LOE of I (4%). Articles typically addressed the arthroscopic management (n = 11, 22%), whereas anatomy/classification (n = 10, 20%), and outcomes (n = 9, 18%) also were reported. **Conclusions:** This review provides a quantitative analysis of the most-referenced literature pertaining to SLAP tears. This body of knowledge helps surgeons search for literature regarding these injuries and identify trends regarding SLAP tear research. **Clinical Relevance:** This research provides practitioners with an easily accessible and comprehensive collection of the major contributions regarding SLAP tears and offers insight into future areas for research.

SLAP tears represent a relatively young topic in orthopaedics. Although he did not give the injury its signature name, Dr. James Andrews originally described these lesions in 1985, when he arthroscopically examined 73 baseball pitchers and overhead throwing athletes' dominant throwing shoulders.¹ Dr. Andrews found that there was a "high frequency of tearing of the anterosuperior aspect of the glenoid

labrum," and that this phenomenon "may be caused by the biceps tendon actually detaching portions of the glenoid labrum."¹ This landmark research helped to pave the way for Snyder et al.,² who coined the term SLAP to describe "injury of the superior labrum which begins posteriorly and extends anteriorly, stopping before or at the mid-glenoid notch and including the 'anchor' of the biceps tendon to the labrum." Snyder et al.³ have expanded upon this seminal research, noting a SLAP tear prevalence of 6% in 2375 patients undergoing shoulder procedures.

Since this time, there has been an abundance of research regarding physical examination, imaging modalities, management, and outcomes of these injuries that has guided the treatment of SLAP lesions. For example, early research advocated for the repair of type II SLAP lesions,⁴ but more current research has shown that biceps tenodesis can be an effective alternative to repair, and this treatment now represents the preferred management in individuals older than 35 years old.^{5,6} When attempting to understand the current management of SLAP lesions, it is beneficial to understand the progression of knowledge within the field. This can be

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daunting, however, given the large volume of literature published. Therefore, there is utility in having access to an objective and organized list of the most influential articles.

To generate a better understanding of the research surrounding SLAP tears, a bibliometric analysis can be implemented, which is a study tool used within the medical community that quantifiably ranks the top cited articles regarding a specific topic. This affords researchers facilitated access to the most influential articles in a certain field, and ultimately allows one to better understand trends and important milestones, formulate new queries based on research deficiencies, and assess the quality of available literature. The purpose of this review was to identify and evaluate the top 50 most-cited articles pertaining to SLAP tears.

Methods

The ISI Web of Knowledge database (also known as the Web of Science Core Collection, which includes MEDLINE, BIOSIS Citation Index, Scielo Citation Index, KCI-Korean Journal Database, and Russian Science Citation Index) was used to conduct a query for articles pertaining to SLAP tears because this search engine has been shown to produce accurate queries and also helps to facilitate the analysis of study quality and impact, amongst other factors.⁷ Our query was conducted in April 2020 with multiple Boolean operative combinations performed by 2 independent reviewers. The Boolean operative that yielded the largest search results was the following: "SLAP" or "SLAP tear" or "superior labral anterior to posterior" or "superior labral anterior to posterior tear" or "labral tear" or "labral arthroscopy" or "labral management" or "labral" or "superior labrum anterior to posterior" or "superior labrum anterior to posterior tear" or "labrum tear" or "labrum arthroscopy" or "labrum management" or "labrum."

Our initial screen was not restricted to language, data range, journal, or article type. Once a list of articles was generated, the query results, sorted by descending number of total citations, were refined to include only peer-reviewed original articles, review articles, or editorials. Level of evidence (LOE) was not a factor so long as the article matched our initial search criteria and pertained to SLAP tears. To confirm this, articles were finally screened by title and abstract to ensure our data set only pertained to SLAP tears. If the primary focus of the article did not pertain to SLAP tears, it was subsequently excluded.

Based on the aforementioned criteria, 2 independent authors conducted separate searches and subsequently screened the articles from their respective searches. Both lists were then compared, and a final list of

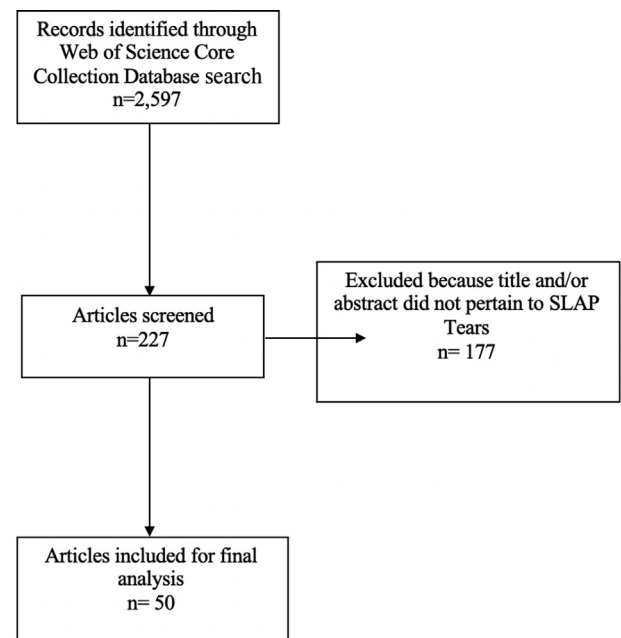


Fig 1. Modified PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart.

included articles was compiled by the first author and verified by the senior author. Articles on the final list were further reviewed to extract the following data: manuscript title, first author, total citation count, year of publication, citation density since publication, current citation rate since 2013, journal, country of origin, and level of evidence. If 2 articles had the same number of citations, citation density since publication was used as a tiebreaker. LOE was determined by one author via the Oxford evidence-based medicine levels of evidence and verified by the senior author.

After individual review of each article, articles were then placed into a predetermined thematic category based on the research question the authors attempted to address. The categories included the following: (I) Physical Exam, (II) Diagnostics, (III) Arthroscopic Management, (IV) Outcomes, (V) Anatomy and/or Classification, and (VI) Comprehensive Review.

Statistics

The Shapiro–Wilk test was used to examine the distribution of individual variables for normality. Data that were normally distributed were presented with mean and standard deviation. One-way analysis of variance also was used to test for differences within normally distributed data, whereas the Kruskal–Wallis test was used for skewed data. The Spearman Rank was then used to test for correlations amongst any variables. Statistical significance was set a $P < .05$. Microsoft Excel, version 16.33 (Redmond, WA) was used for all statistical analysis.

Table 1. Fifty Most-Cited Articles Regarding SLAP Lesions

Rank	Article Title	First Author	Reference	Year	Citation Count	Citation Density (Citations per Year)		Journal	Country	Category*	LOE
						since Publication Year)	Usage Count since 2013				
1	Slap Lesions of the Shoulder	Snyder SJ	2	1990	802	26.73	19	<i>Arthroscopy</i>	U.S.A.	VI	IV
2	Glenoid Labrum Tears Related to the Long Head of the Biceps	Andrews JR	1	1985	509	14.54	18	<i>American Journal of Sports Medicine</i>	U.S.A.	V	IV
3	Type II SLAP Lesions: Three Subtypes and Their Relationships to Superior Instability and Rotator Cuff Tears	Morgan CD	8	1998	399	18.14	11	<i>Arthroscopy</i>	U.S.A.	V	II
4	Superior Labrum Biceps Tendon Complex Lesions of the Shoulder	Maffet MW	9	1995	325	13.00	12	<i>American Journal of Sports Medicine</i>	U.S.A.	V	IV
5	An Analysis of 140 Injuries to the Superior Glenoid Labrum	Snyder SJ	3	1995	276	11.04	2	<i>Journal of Shoulder and Elbow Surgery</i>	U.S.A.	V	IV
6	The Peel-Back Mechanism: Its Role in Producing and Extending Posterior Type II SLAP Lesions and its Effect on SLAP Repair Rehabilitation	Burkhart SS	10	1998	265	12.05	15	<i>Arthroscopy</i>	U.S.A.	V	IV
7	Superior Labrum Anterior-Posterior lesions: Diagnosis with MR Arthrography of the Shoulder	Bencardino JT	11	2000	183	9.15	11	<i>Radiology</i>	U.S.A.	II	II
8	Arthroscopic Treatment of Isolated Type II SLAP Lesions: Biceps Tenodesis as an Alternative to Reinsertion.	Boileau P	5	2009	174	15.82	14	<i>American Journal of Sports Medicine</i>	France	III	III
9	The Disabled Throwing Shoulder: Spectrum of Pathology. Part II: Evaluation and Treatment of SLAP Lesions in Throwers.	Burkhart SS	12	2003	172	10.12	27	<i>Arthroscopy</i>	U.S.A.	III	IV
10	Effect of Lesions of the Superior Portion of the Glenoid Labrum on Glenohumeral Translation	Pagnani MJ	13	1995	163	6.52	1	<i>JBJS- American Volume</i>	U.S.A.	V	Cadaver
11	Clinical Features of the Different Types of SLAP Lesions - An Analysis of One Hundred and Thirty-Nine Cases	Kim TK	14	2003	157	9.24	16	<i>JBJS- American Volume</i>	U.S.A.	V	IV
12	Tears of the Glenoid Labrum- MR Imaging of 88 Arthroscopically Confirmed Cases	Legan JM	15	1991	157	5.41	2	<i>Radiology</i>	U.S.A.	II	II
13	A Cadaveric Model of the Throwing Shoulder: A Possible Etiology of Superior Labrum Anterior-to-Posterior Lesions	Grossman MG	16	2005	145	9.67	14	<i>JBJS- American Volume</i>	U.S.A.	V	Cadaver
14	No Advantages in Repairing a Type II Superior Labrum Anterior and Posterior (SLAP) Lesion when Associated with Rotator Cuff Repair in Patients over Age 50: A Randomized Controlled Trial.	Franceschi F	17	2008	131	10.92	7	<i>American Journal of Sports Medicine</i>	Italy	IV	I

(continued)

Table 1. Continued

Rank	Article Title	First Author	Reference	Year	Citation Count	Citation Density	Usage Count since 2013	Journal	Country	Category*	LOE
						(Citations per Year since Publication Year)					
15	Outcomes After Arthroscopic Repair of Type-II SLAP Lesions.	Brockmeier SF	18	2009	126	11.45	9	<i>JBJS- American Volume</i>	U.S.A.	IV	IV
16	Superior Labral Anterior Posterior (SLAP) Lesions of the Glenoid Labrum: Reliability and Accuracy of MR Arthrography for Diagnosis.	Jee WH	19	2001	125	6.58	3	<i>Radiology</i>	U.S.A.	II	IV
17	Outcomes of Isolated Type II SLAP Lesions Treated with Arthroscopic Fixation Using a Bioabsorbable Tack.	Cohen DB	20	2006	115	8.21	5	<i>Arthroscopy</i>	U.S.A.	IV	IV
18	Accuracy of the Speed's and Yergason's Tests in Detecting Biceps Pathology and SLAP lesions: Comparison with Arthroscopic Findings.	Holtby R	21	2004	112	7.00	21	<i>Arthroscopy</i>	Canada	I	II
19	The Trans-Rotator Cuff Approach to SLAP Lesions: Technical Aspects for Repair and a Clinical Follow-Up of 31 Patients at a Minimum of 2 Years.	O'Brien SJ	22	2002	110	6.11	6	<i>Arthroscopy</i>	U.S.A.	III	IV
20	Biceps Load Test II: A Clinical Test for SLAP Lesions of the Shoulder.	Kim SH	23	2001	103	5.42	21	<i>Arthroscopy</i>	South Korea	I	II
21	Arthroscopic Repair of Partial-Thickness Rotator Cuff Tears and SLAP Lesions in Professional Baseball Players.	Conway JE	24	2001	100	5.26	4	<i>Orthopedic Clinics of North America</i>	U.S.A.	III	IV
22	Arthroscopic Stabilization of Type II SLAP Lesions Using an Absorbable Tack.	Samani JE	25	2001	94	4.95	7	<i>Arthroscopy</i>	U.S.A.	III	IV
23	Clinical Testing for Tears of the Glenoid Labrum	Guanche CA	26	2003	90	5.29	13	<i>Arthroscopy</i>	U.S.A.	I	II
24	SLAP Lesions in the Overhead Athlete	Burkhart SS	27	2001	83	4.37	10	<i>Orthopedic Clinics of North America</i>	U.S.A.	VI	IV
25	A Prospective Analysis of 179 Type 2 Superior Labrum Anterior and Posterior Repairs Outcomes and Factors Associated with Success and Failure	Provencher MT	4	2013	82	11.71	20	<i>American Journal of Sports Medicine</i>	U.S.A.	IV	III
26	Demographic Trends in Arthroscopic SLAP Repair in the United States.	Zhang AL	28	2012	81	10.13	4	<i>American Journal of Sports Medicine</i>	U.S.A.	III	Review
27	SLAP Lesions: A Retrospective Multicenter Study.	Handelberg F	29	1998	81	3.68	11	<i>Arthroscopy</i>	Belgium	III	III
28	Clinical Utility of Traditional and New Test in the Diagnosis of Biceps Tendon Injuries and Superior Labrum Anterior and Posterior Lesions in the Shoulder	Ben Kibler W	30	2009	78	7.09	15	<i>American Journal of Sports Medicine</i>	U.S.A.	I	II

(continued)

Table 1. Continued

Rank	Article Title	First Author	Reference	Year	Citation Density (Citations per Year)		Usage Count since 2013	Journal	Country	Category*	LOE
					Citation Count	Year)					
29	The diagnosis and Treatment of Superior Labrum Anterior and Posterior (SLAP) Lesions	Nam EK	31	2003	77	4.53	14	<i>American Journal of Sports Medicine</i>	U.S.A.	VI	Review
30	The Outcome of Type II SLAP Repair: A Systematic Review.	Gorantla K	32	2010	75	7.50	13	<i>Arthroscopy</i>	U.S.A.	IV	IV
31	Biceps Load Test: A Clinical test for Superior Labrum Anterior and Posterior Lesions in Shoulders with Recurrent Anterior Dislocations	Kim SH	33	1999	74	3.52	9	<i>American Journal of Sports Medicine</i>	South Korea	I	II
32	Outcomes of Type II Superior Labrum Anterior to Posterior (SLAP) Repair: Prospective Evaluation at a Minimum 2-year Follow-Up	Friel NA	34	2010	68	6.80	16	<i>Journal of Shoulder and Elbow Surgery</i>	U.S.A.	IV	IV
33	CT and MR Arthrography of the Normal and Pathologic Anterosuperior Labrum and Labral-Bicipital Complex	De Maeseneer M	35	2000	67	3.35	2	<i>Radiographics</i>	Belgium	II	IV
34	Arthroscopic Stapling for Detached Superior Glenoid Labrum	Yoneda M	36	1991	66	2.28	3	<i>JBJS-British Volume</i>	Japan	III	IV
35	Analysis of Interobserver and Intraobserver Variability in the Diagnosis and Treatment of SLAP Tears Using The Snyder Classification	Gobezie R	37	2008	64	5.33	5	<i>American Journal of Sports Medicine</i>	U.S.A.	V	II
36	MR Diagnosis of Superior Labral Anterior Posterior (SLAP) Injuries of the Glenoid Labrum: Value of Routine Imaging Without Intraarticular Injection of Contrast Material.	Monu JU	38	1994	62	2.38	0	<i>American Journal of Roentgenology</i>	U.S.A.	II	IV
37	Poor Outcomes After SLAP Repair: Descriptive Analysis and Prognosis	Katz LM	39	2009	60	5.45	7	<i>Arthroscopy</i>	U.S.A.	IV	III
38	SLAP Lesions: Anatomy, Clinical Presentation, MR Imaging Diagnosis and Characterization.	Chang D	40	2008	60	5.00	14	<i>European Journal of Radiology</i>	U.S.A.	II	Review
39	MR Imaging in the Evaluation of SLAP Injuries of the Shoulder: Findings in 10 Patients.	Cartland JP	41	1992	60	2.14	2	<i>American Journal of Roentgenology</i>	U.S.A.	II	IV
40	Superior Labrum Anterior and Posterior Lesions of the Shoulder Incidence Rates Complications, and Outcomes as Reported by American Board of Orthopedic Surgery Part II Candidates	Weber SC	42	2012	58	7.25	11	<i>American Journal of Sports Medicine</i>	U.S.A.	IV	III
41	The Diagnosis Classification, and Treatment of SLAP Lesions	Powell SE	43	2004	58	3.63	3	<i>Operative Techniques in Sports Medicine</i>	U.S.A.	VI	Review

(continued)

Table 1. Continued

Rank	Article Title	First Author	Reference	Year	Citation Count	Citation Density	Usage Count since 2013	Journal	Country	Category*	LOE
						(Citations per Year since Publication Year)					
42	Unstable Isolated SLAP Lesion: Clinical Presentation and Outcome of Arthroscopic Fixation.	Rhee YG	44	2005	57	3.80	8	<i>Arthroscopy</i>	South Korea	III	IV
43	Superior Labrum Anterior-Posterior (SLAP) Tears: Evaluation of Three MR Signs on T2-Weighted Images	Tuite MJ	45	2000	56	2.80	0	<i>Radiology</i>	U.S.A.	II	II
44	Current Concepts in the Recognition and Treatment of Superior Labral (SLAP) Lesions	Wilk KE	46	2005	54	3.60	4	<i>Journal of Orthopaedic & Sports Physical Therapy</i>	U.S.A.	VI	Review
45	The Mechanism of Creation of Superior Labrum Anterior, and Posterior Lesions in a Dynamic Biomechanical Model of the Shoulder: The role of Inferior Subluxation	Bey MJ	47	1998	54	2.45	12	<i>Journal of Shoulder and Elbow Surgery</i>	U.S.A.	V	Cadaver
46	The Rising Incidence of Arthroscopic Superior Labrum Anterior and Posterior (SLAP) Repairs.	Onyekwelu I	48	2012	52	6.50	6	<i>Journal of Shoulder and Elbow Surgery</i>	U.S.A.	III	III
47	Arthroscopic Superior Labrum Anterior-Posterior Repair in Military Patients.	Enad JG	49	2007	51	3.92	7	<i>Journal of Shoulder and Elbow Surgery</i>	U.S.A.	III	IV
48	Injuries to the Glenoid Labrum Including SLAP Lesions	Rames RD	50	1993	47	1.74	1	<i>Orthopedic Clinics of North America</i>	U.S.A.	VI	IV
49	Long-Term Outcome After Arthroscopic Repair of Type II SLAP lesions: Results According to Age and Workers' Compensation Status	Denard PJ	51	2012	46	5.75	8	<i>Arthroscopy</i>	U.S.A.	IV	IV
50	Diagnostic Accuracy of Five Orthopedic Clinical Tests for Diagnosis of Superior Labrum Anterior Posterior (SLAP) Lesions.	Cook C	52	2012	46	5.75	28	<i>Journal of Shoulder and Elbow Surgery</i>	U.S.A.	I	I

LOE, level of evidence.

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

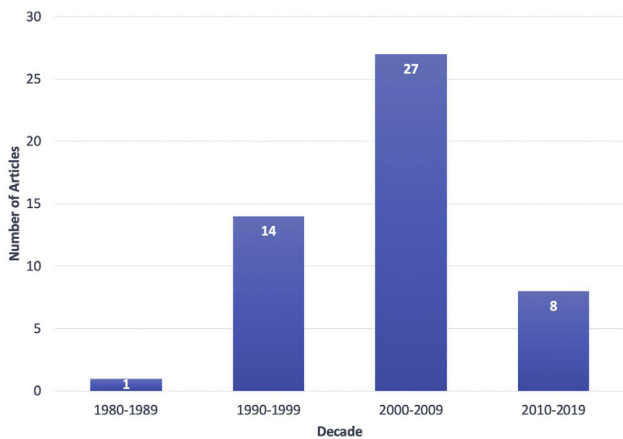


Fig 2. Journal articles published by decade.

Results

Our initial search yielded 2597 articles. Within this cohort, after reviewing 227 potential articles, the top 50 publications pertaining to SLAP tears that fulfilled our search criteria were identified (Fig 1). The list of 50 articles is displayed in Table 1.^{1-5,8-52} The 50th-cited article in our study was the 227th study that appeared in our search; therefore, 177 studies were excluded until our list was completed. The publication date range for the 50 publications was from 1985 to 2013. The top article was cited 802 times, whereas the 50th-ranked article was cited 46 times. When we accounted for all 50 publications, the average number of citations per publication was 131, whereas the average citation density since year of publication was 7.3. That being said, the average citation rate since 2013 for our cohort was 9.82.

Andrews et al.¹ published the earliest article in 1985 describing SLAP lesions (despite not coining the term SLAP, which was done by Snyder et al.² in 1990) in our cohort. The 1990 article by Snyder et al.² was the top-cited article in the literature, and its citation density, defined as the average number of citations per year since publication, was also the greatest in the group (26.73). More than one half of articles were published between 2000 and 2009 (54%) versus 1990 and 1999 (28%), 2010 and 2019 (18%), and 1980 and 1989 (2%) (Fig 2). The most prolific years of publication were 2001 and 2012 (5 manuscripts per year), followed by 2003 (4 manuscripts).

While Snyder et al. had the greatest citation density since publication, the 50th-ranked article in our search by Cook et al.⁵² yielded the greatest citation density since 2013 (28). Unsurprisingly, the 48th-ranked article claimed the lowest citation density since year of publication (1.74, published in 1993), and has been cited only once since 2013. When looking at citation density since year of publication, a correlation coefficient $R = -0.08$ ($P = .55$) was seen, whereas a regression analysis found an R^2 value of 0.006 (Fig 3A). When we looked specifically at citation rate since 2013, a greater correlation coefficient value was found ($R = 0.23$) with an R^2 value 0.053 ($P = .01$) (Fig 4).

The United States is by far the most prolific contributor to publications on our top 50 list, accounting for 82% of publications (Fig 5). Twelve different journals published articles pertaining to SLAP tears, with *Arthroscopy* accounting for the greatest number (15 articles, 30%) (Fig 6). The next greatest contributors were *American Journal of Sports*

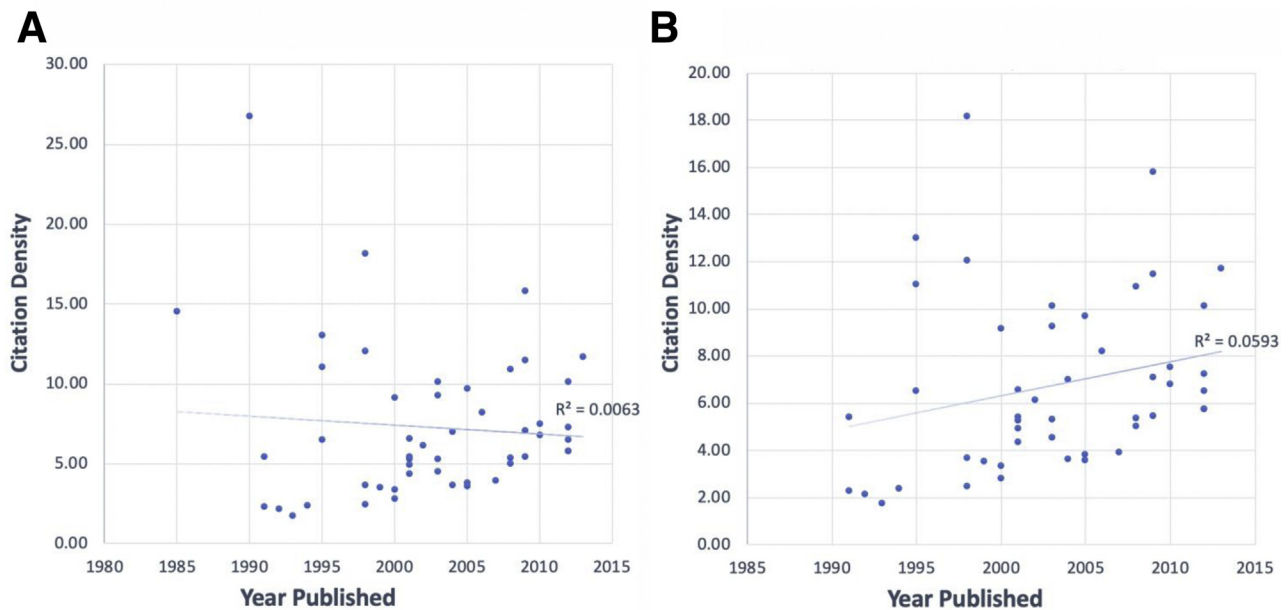


Fig 3. (A) Citation density versus year published for all 50 manuscripts. (B) Citation density versus year published for the 48 manuscripts published after the influential works of both Andrews et al and Snyder et al.

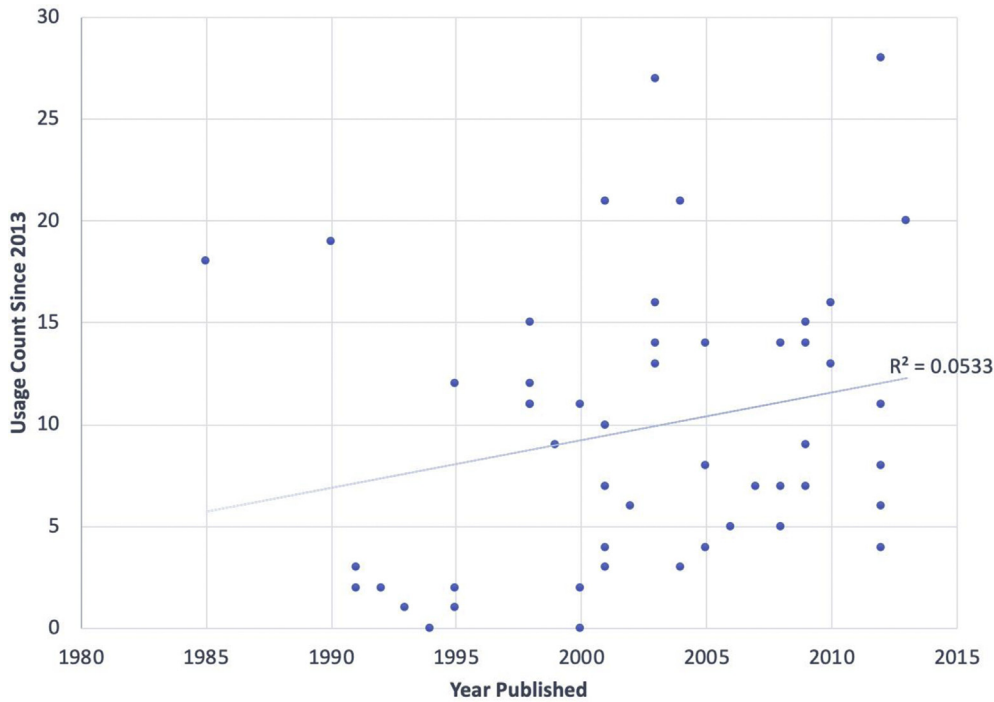


Fig 4. Usage count since 2013 versus year published.

Medicine (n = 11, 22%) and *Journal of Shoulder and Elbow Surgery* (n = 6, 12%).

Most articles were graded with a LOE of IV (n = 24, 48%), followed by articles with an LOE of II (n = 10, 20%) (Fig 7A). Only 2 articles achieved an LOE of I (4%). When addressing the mean number of citations per LOE, articles with an LOE of IV had the highest mean value, while LOE of III had the lowest (Fig 7B). However, a one-way analysis of variance demonstrated no statistically significant difference in mean number of citations per LOE (P = .66).

Based on our thematic categories, most articles addressed arthroscopic management of SLAP tears (n = 11, 22%), whereas anatomy/classification came in second (n = 10, 20%), and outcomes in third (n = 9, 18%) (Fig 8). When combining all publications that addressed the diagnosis and classification of SLAP tears as the primary research question, we found that most articles on our list (n = 24, 48%) could be grouped into this category. When combining all publications that addressed some facet of surgical management, 20 manuscripts (40%) could be grouped together. Six (12%) of the articles were comprehensive reviews of SLAP tears. Lastly, we found multiple first authors who contributed to multiple publications. Burkhart et al. published the most (n = 3) and claimed the 6th-, 9th-, and 24th-top cited articles pertaining to SLAP tears. Snyder et al. and Kim et al. each contributed to 2 publications.

Discussion

As the data clearly show, SLAP tears are a burgeoning focus within orthopaedics, and although most articles on our list were published within the last 2 decades, the seminal research by Andrews et al.¹ and Snyder et al.² remain the most influential articles in the field.

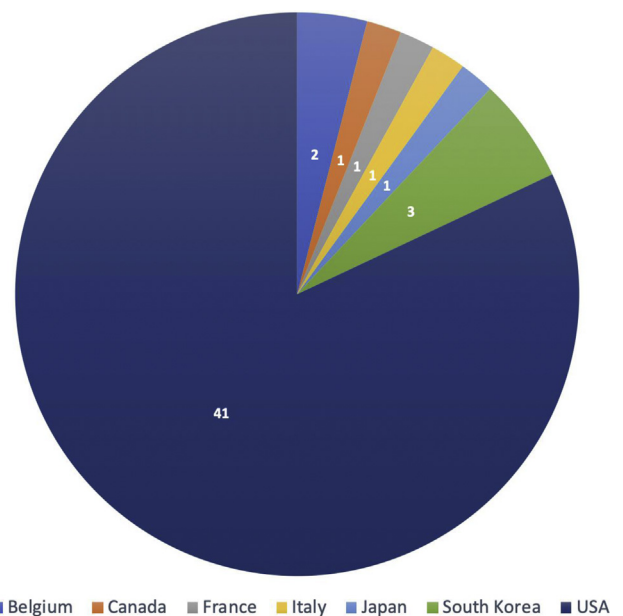
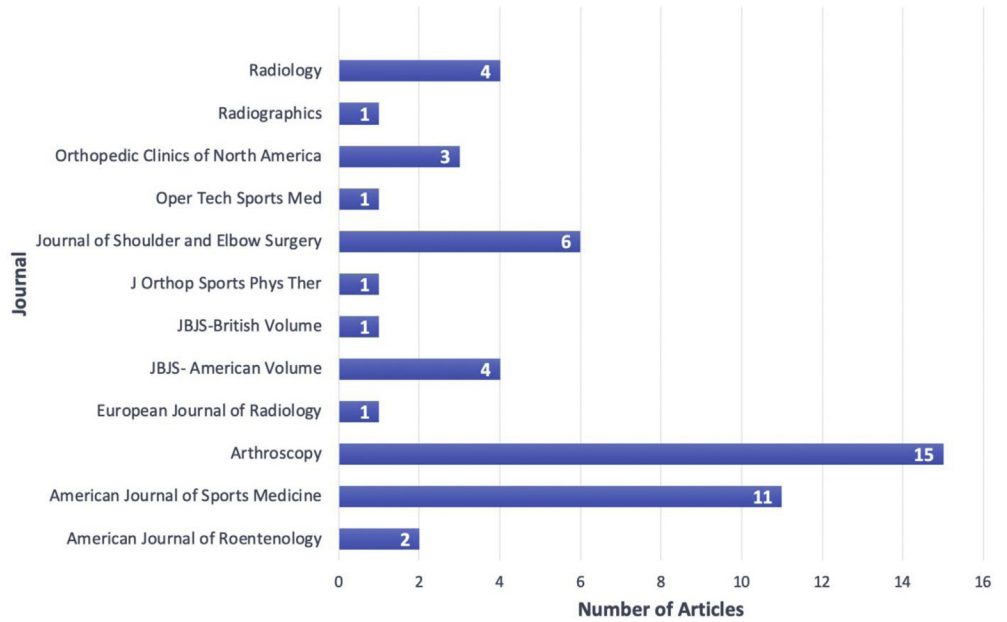


Fig 5. Journal articles by country of origin.

Fig 6. Number of articles published per journal.



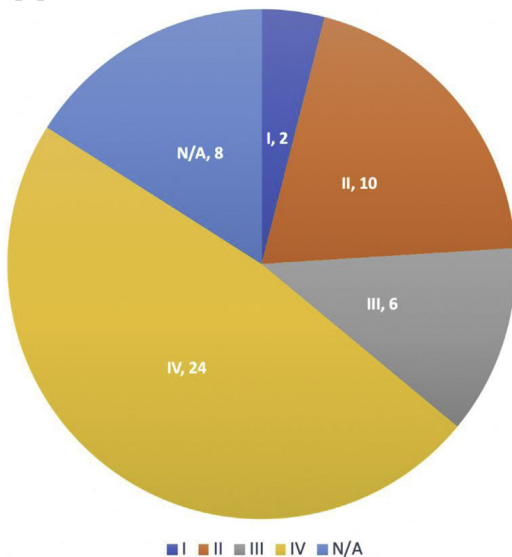
Furthermore, this study demonstrates that there is a dearth of research with strong levels of evidence regarding SLAP lesions, indicating that more high-caliber research is required to make more confident assertions about SLAP lesion care.

Review of these “top articles” helps to demonstrate the progression in collective understanding and management heuristics and allows surgeons to identify the important articles that one must be familiar with when managing SLAP lesions. For example, since Snyder et al.² first characterized the 4 different SLAP tear types

in their landmark manuscript, much research has been performed to better characterize, diagnose, and manage these injuries. The Snyder classifications are still being used today, a testament to the research performed and its impact on the field.

Snyder et al.² also noted in their 1990 article “SLAP Lesions of the Shoulder” (the top-cited article, with 802 citations), that type II SLAP tears were treated with debridement of the frayed labral tissue and the superior glenoid to promote healing, but that suture/ anchor fixation was not performed because fixation

A



B

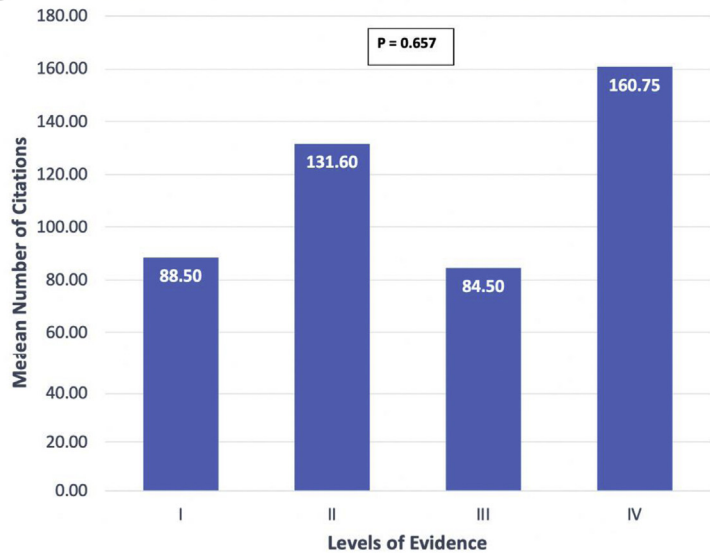


Fig 7. (A) Journal articles published by levels of evidence and (B) Mean number of citations per level of evidence.

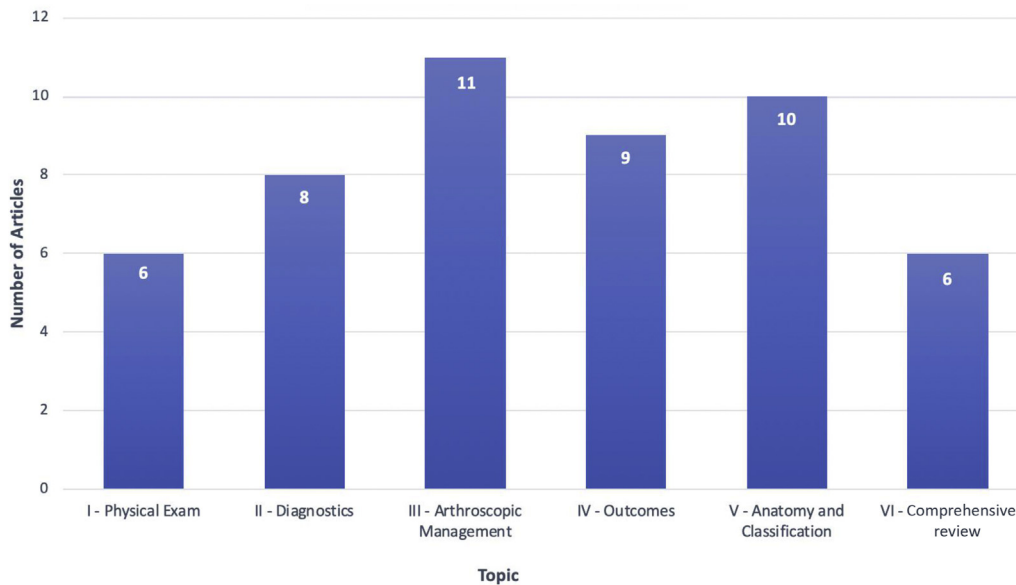


Fig 8. Journal articles published by topic discussed.

was not “feasible.” Since then, advances in arthroscopy and materials have allowed for the development of novel fixation methods that circumvent these problems. In fact, one of the earliest articles that specifically described the arthroscopic management of SLAP tears, number 34 on our list, “Arthroscopic stapling for detached superior glenoid labrum,” demonstrates just how much progress has been made with regards to management.³⁶ In this article, Yoneda et al.³⁶ describe their method of stapling the detached labrum to the superior glenoid, and go on to describe how they performed second-look arthroscopy with planned staple removal on all 10 of their patients. While the idea of performing 2 planned arthroscopic surgeries to implant and remove a staple into a SLAP lesion may seem archaic today, it was pioneering research in the realm of SLAP management at that time. Ultimately, review of this older research shows how the treatment of SLAP lesions has evolved over time and affords researchers with understanding as to what knowledge gaps still exist within the field.

Snyder et al.² noted that SLAP lesions can only be diagnosed arthroscopically and mentioned that magnetic resonance arthrography may eventually help with preoperative diagnosis. Our bibliometric study actually shows that much radiographic research has been published since this time with the goal of identifying the best imaging modalities, signature imaging findings, and associated lesions in relation to SLAP tears. Eight (16%) of the 50 most-cited SLAP articles dealt with imaging diagnostics, highlighting physician interest in facilitated diagnoses and establishing imaging criteria for SLAP lesions.

When analyzing the LOE of the manuscripts on our list, there were only 2 Level I studies within the top 50 most-cited articles on SLAP tears (Fig 7A), one of which dealt with physical examination findings; the other dealt with long-term outcomes. Only 3 of the 9 articles addressing outcomes had an LOE of at least III, whereas research addressing physical examination had the strongest LOE: all 6 articles within this category had an LOE of II or greater. Even when analyzing arthroscopic management/findings, the most frequently published thematic category on our list, only 2 of the 11 studies managed an LOE of II (none had an LOE of I). This highlights the need for more randomized controlled trials (RCT) dealing with SLAP tear management and outcome assessment, and the current deficiency is likely due to the fact that these are technically difficult studies to organize and require stringent follow up. Interestingly, 3 of the 50 articles (6%) were cadaveric studies that sought to analyze the biomechanics of SLAP tears and their repair techniques, and they were published between 1995 and 2005 and all have an LOE of V.^{13,16,47} Perhaps there are newer cadaveric studies published, but this dearth of influential cadaveric research highlights an exciting area for future study.

Four of the 5 most-cited publications on our list (80%) are level IV studies, and most of the articles within this analysis were level IV studies (24, 48%) (Fig 7A). Despite failing to reach significance, we also showed in Figure 7B that the greatest number of mean citations per LOE occurred with level IV evidence, although level II evidence was a close second. This again demonstrates that there has been a relative lack of high-quality level I and II evidence guiding clinical practice, although the authors do acknowledge that

there may be other level I and II studies that have recently been published and are not included on this list because they have not yet accumulated enough citations.

When addressing thematic categories in general (Fig 8), the largest proportion of articles ($n = 11$, 22%) dealt with the arthroscopic management of SLAP lesions. In fact, when combining categories related to surgery, almost one half of the articles on our list addressed either surgical management or related outcomes ($n = 20$, 40%). These trends highlight that surgeons are most interested in providing safe and effective management for their patients. Review of the 11 publications that dealt with arthroscopic management showed that the majority were published in the last 2 decades, signifying how young the topic is and how rapid the evolution has been with regards to management.

As previously mentioned, the greatest concentration of articles was published between the years 2000 and 2009, whereas the second-greatest concentration occurred between 1990 and 1999, and the remaining articles were either published between 1980 and 1989 or in the last decade (Fig 2). These trends highlight how fledgling the current body of knowledge is, but also highlight how using the total number of citations for an article as a measure of impact may be misleading, as this does not necessarily indicate the publication quality or the level of current clinical use. In fact, a bibliometric analysis is a detriment to more recent publications due to the fact that these newer articles have not had the same amount of time to accrue a high number of citations in comparison to the older articles. We believe this is highlighted in Figure 2, which clearly shows an increasing number of cited articles in each subsequent decade starting from 1980 onwards. The exception is the most recent decade, likely owing to the fact that these articles have not had time to reach high total citation numbers. Referencing Figure 3, it appears that manuscripts published between 2010 and 2019 have had the greatest usage count since 2013, indicating that the current impact of these newer articles may be more significant than ranking by the total number of citations would lead readers to believe.

When reviewing articles included in a bibliometric analysis, another tool that researchers can employ to better understand the influence of particular literature on the field is the citation density metric. This is calculated by dividing the total number of citations an article has accrued by the total number of years it has been in print. Theoretically, an older article that has accrued a large total number of citations but that currently demonstrates a declining rate of citation will have a lower citation density, and a younger article that has a smaller total number of citations but has many

citations relative to its young age will have a higher citation density. One may expect that as newer articles gain traction and subsequent citations, a correlation may be seen between citation density and year published. As further testament to the influence of Snyder et al.'s work, the "SLAP Lesions of the Shoulder" article demonstrated the greatest citation density (26.73) of the group despite being the second oldest publication in the group. Furthermore, as seen in Figure 3A, there was no correlation between citation density and year published when analyzing the most influential SLAP articles ($R = -0.08$), perhaps in large part due to the influence and resultant citation density of the articles of Andrews et al.¹ and Snyder et al.² When analyzing the citation density of the 48 most-cited publications since these 2 manuscripts, a modest correlation between citation density and year published is observed ($R = 0.24$), indicating just how impactful these early articles were (Fig 3B). In time, one should expect the citation density slope to rise as newer articles gain traction and influence.

Limitations

Bibliometric analyses serve as valuable tools for clinicians and learners but have inherent flaws. The authors used a careful approach when inputting search terms in the ISI Web of Knowledge database so as to ensure that all highly influential articles were captured within the analysis. Nevertheless, the omission of highly influential articles based on inadequate search terms or miscategorized articles within the database is an important possibility that cannot be entirely eliminated.⁵³

Citation numbers, which demonstrate impact and not necessarily quality, can potentially be affected by certain practices, such as self-citations or sub-publications. Citations can also be adversely affected if published in non-indexed journals, textbooks, lectures, or digital media, which the ISI Web of Knowledge database does not take into account. Another point worth noting is that novel studies may be cited more often than replication studies, which are important for the validation of earlier findings. Lastly, the newest articles, which simply have not had time to garner enough citations to be included on a top 50 list, will be completely excluded from such analyses.

Conclusions

This review provides a quantitative analysis of the most referenced literature pertaining to SLAP tears. This body of knowledge helps surgeons search for literature regarding these injuries and identify trends regarding SLAP tear research.

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