Significant demographic and geographic differences exist in the reporting of superior labrum from anterior to posterior tear literature: a systematic review

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ABSTRACT

Importance Superior labrum from anterior to posterior (SLAP) pathology can result in significant pain and functional limitation for a wide variety of patients. Although many different options have been described for the diagnosis and treatment of SLAP pathology, there is little high-quality evidence to support a given diagnosis/treatment method.

Objective The aim of this study was to review the global demographics and trends of SLAP literature, diagnosis, management and consistency of reported outcomes

Evidence review We performed a systematic search for studies addressing SLAP pathology published over the last 10 years. Extracted data included sample size, study location, intervention, outcome measures reported, sex distribution and level of evidence. Management was compared between geographic areas.

Findings We identified 363 studies reporting on SLAP management over the past decade that met our inclusion and exclusion criteria. The majority of studies originated from North America (50.4%), followed by Asia (22.3%) and Europe (20.9%) with most studies describing results of operative intervention originating from the USA (58.5%). We found the majority of literature related to SLAP pathology was case series level data (44.0%) consisting of sample sizes of less than 40 patients (50.1%). The majority of studies presented clinical outcome scores with the ASES score being the most commonly reported (28.3%). The most common complications reported were pain (32.6%) and stiffness (30.4%) following surgical intervention.

Conclusions Current literature related to the management of SLAP pathology demonstrates a predominance of North American studies with low levels of evidence consisting of small sample sizes and variably reported clinical outcome scores. Future research should focus on multicentre, randomised studies to clarify current controversies in the surgical versus non-operative management of SLAP pathology.

Relevance Significant demographic and geographic differences exist in the diagnosis and treatment of SLAP.

Level of evidence Level IV, systematic review of level I–IV studies.

What is already known

- Superior labral pathology has been studied extensively with little consensus in diagnosis and treatment.
- Superior labrum from anterior to posterior (SLAP) tears can be managed with a variety of treatment options including non-operative management, SLAP repair versus debridement, biceps tenodesis or biceps tenotomy, with little information to suggest one treatment over another.

What are the new findings

- Most literature regarding SLAP tear pathology is from North America.
- There is little high-quality (levels 1 and 2) evidence published regarding the diagnosis and treatment of SLAP pathology.
- SLAP tear research is predominantly performed in the young, male demographic.

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INTRODUCTION

Injury to the superior labrum is commonly described as a superior labrum from anterior to posterior (SLAP) tear and involves fraying or detachment of the superior labrum from the glenoid.[1] These injuries have been classified into various subgroups depending on the degree of detachment and the involvement of the biceps tendon.[2] While these injuries can occur in elite athletes, they often are present in older patients with lower physical demands. SLAP tears can be traumatic or insidious in nature and can result from forceful traction to the arm, direct compression loads and repetitive overhead throwing activities.[1 2] In addition, SLAP tears do not commonly occur in isolation. Kim *et al*[3] arthroscopically examined 136 shoulders with SLAP lesions and reported that 88% were found to have coexistent shoulder pathology.

Treatment often is variable depending on the characteristics of the tear, patient demographics and the physical demands of the patient. Non-surgical management with physical therapy and rehabilitation often is the initial treatment for the majority of patients presenting with SLAP pathology. This includes posterior capsular stretching, strengthening of the rotator cuff muscles and scapular stabilisers and correction of scapular mechanics. Surgical options commonly include arthroscopic debridement, repair, biceps tenodesis or tenotomy.[1–3]

Interest in the management of SLAP pathology has grown exponentially over the past decade. Controversy exists regarding optimal management

of SLAP pathology, which includes non-operative management, SLAP repair, biceps tenotomy and/or biceps tenodesis. No review to date has investigated the geographic trends associated with these SLAP tear management options. The aim of this systematic review is to investigate the global demographics and quality of evidence in SLAP tear literature as well as geographical variation in outcomes reporting and management. We hypothesise that the majority of SLAP tear literature originates from North America, where many of the diagnostic and treatment options for SLAP tears have been developed. Furthermore, we hypothesise that the quality of evidence by which clinicians base treatment decisions for SLAP pathology is limited, with a minority of publications being of level 1 or level 2 evidence.

METHODS

This study was conducted according to the methods of the Cochrane Handbook and is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.[4 5]

Study eligibility

Studies meeting the following inclusion criterion were included in this review: publication in a peer-reviewed journal over the last 10 years, focused on SLAP tears in any age or gender, all levels of evidence and published/translation available in the English language. We excluded editorial comments, topic reviews, systematic reviews, letters to the editor and instructional course lectures.

Identification of studies

Electronic databases (MEDLINE, Embase and Cochrane Library) were searched for SLAP tear studies over the past decade from 10 September 2006 to 9 September 2016. The search was conducted on 10 September 2016. The search strategy used the following search terms: SLAP, superior labrum anterior and posterior. The associated subheadings with these terms were also searched. MeSH and EMTREE terms were used to increase search sensitivity. PubMed was searched for articles published ahead of print. The articles were initially screened for eligibility using titles and abstracts by two authors independently (NKB and JMK). Following initial screening, a full-text review was conducted on all studies deemed relevant by two authors independently (NKB and JMK). Any disagreements were resolved by consensus discussion between the reviewers. If a consensus could not be reached, a final decision on inclusion was made with the first author (NKB).

Data extraction

Data was extracted by four reviewers (PR, GR, LT and EP) using a piloted electronic data extraction form (Microsoft Excel, V.15.2, Microsoft Corporation, Redmond, Washington, USA), and all extracted data were verified (NKB and JMK) to ensure accuracy prior to statistical analysis. The following data were extracted from all studies during the full-text review: year of publication, location of study, study design, type of study, type of journal, level of evidence, outcomes measured, sample size, gender and mean age of patients.

Study design was categorised as cadaveric, cohort, case series, case report and randomised controlled trial. The study type was categorised as therapeutic, prognostic, diagnostic, surgical technique, biomechanics or mixed. Each article was grouped under a journal category according to its name and/or description. The type of journal of publication was categorised as radiology, orthopaedic/sports medicine, general medicine, basic science and other.

Data analysis

Interobserver agreement for reviewers' assessments of study eligibility was calculated with the Cohen's kappa coefficient.[6] On the basis of the recommendations of Landis and Koch, a k of 0–0.2 represents slight agreement; 0.21–0.40 represents fair agreement; 0.41–0.60 represents moderate agreement; and 0.61–0.80 represents substantial agreement. A value greater than 0.80 is considered to indicate almost complete agreement. Descriptive statistics were used to summarise the data. All analyses were performed using Microsoft Excel (V.15.2) and SPSS Statistics (V.21).

RESULTS

The electronic search identified 1940 potentially relevant studies. After applying our inclusion/exclusion criteria, limiting the search to a 10-year period (2006–2016), and eliminating duplicate articles, 398 studies were eligible for full-text review. Following full-text review, 363 papers were eligible for inclusion in this systematic review(see online supplementary file). The kappa for overall agreement between reviewers for final eligibility decision was 0.95 (95% CI 0.92 to 0.98), indicating almost perfect agreement.

Characteristics of included studies

The majority of SLAP research was performed in the USA (48%) followed by Korea (13%), Germany (6.3%) and the UK (4.7%). The majority of studies originated from North America (50.4%), followed by Asia (22.3%) and Europe (20.9%) (figures 1 and 2).

A percentage of 53.2 of the publications regarding SLAP pathology were produced in the second half of the reviewed time period (2012–2016), with 46.8% being produced in the first half of the time period (2006–2011), with this difference not being statistically significant (p=0.54) (figure 3). A percentage of 16.8 of studies had a sample size of less than 10 patients with the majority of studies (50.1%) having a sample size of less than 40 patients. A percentage of 78.5 of studies had a sample size of less than 100 patients, and 21.5% of studies had a sample greater than 100. Large studies were rare with only 16 studies during the 10-year period (4.4%) having a sample size greater than 500 (figure 4).

The mean age of all patients involved in clinical studies was 34.6±7.1 years. The majority of included studies reported mean ages between 30 and 40 (33.6%). A percentage of 23.7 of studies reported a mean age between 20% and 30%. A percentage of 18.5 of studies had an average age between 40 and 50 (figure 5). The vast majority of patients in SLAP studies were found to be male at 76.1%. A percentage of 64.6 of studies had greater than 70% males. Only 13.7% of SLAP studies had >50% females.

Reporting and assessment of outcomes

Multiple outcomes reported in the SLAP tear literature were evaluated. The most common outcome reported involved clinical outcomes scores (60.3%, 219/363 publications) followed by physical exam findings (34.2%, 124/363 publications) and imaging findings (31.4%, 114/363 publications). Patient satisfaction scores were the least used outcome, with only 56 publications (15.4%). The most commonly reported clinical outcome score was the American Shoulder and Elbow Surgeons (ASES) score (28.3%, 62/219 studies) followed by the constant score (14.6%, 32/219). Less than 10% of studies reported Rowe,

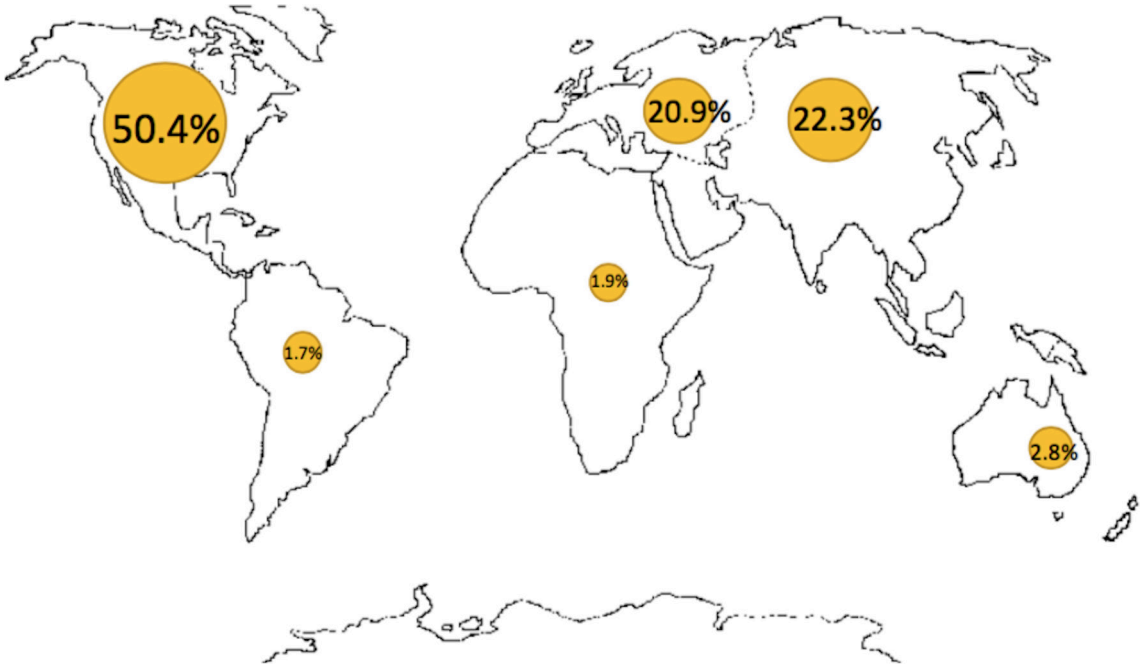

Figure 1 Distribution of publications regarding superior labrum from anterior to posterior pathology by continent.

Western Ontario Shoulder Instability Index (WOSI), the Disabilities of the Arm, Shoulder, and Hand (DASH), short form and Kerlan Jobe Orthopedic Clinic (KJOC) scores (table 1). Studies examining surgical technique and biomechanics of SLAP tear pathology each comprised 8.2% of the total publications. A percentage of 6.2 of studies compared therapeutic options for the treatment of SLAP tears.

Sources and quality of literature

We found that a large portion of available literature (44.0%) on SLAP pathology was case series level data, followed by cohort study designs, which comprised 34.3% of SLAP studies. Individual case reports were 7.2% of studies examining SLAP pathology. Cadaveric studies comprised 7.0% of studies examining SLAP pathology. Only 2.2% of research related to SLAP pathology were randomised control trials.

We found 3.6% of studies classified themselves as level 1 evidence over the 10-year period reviewed. In the last 5 years of the examined time period (2012–2016), only five new level 1 studies have been published on the subject. Level 2 studies consisted of 22.9% of the published literature with 51.8% of these studies published prior to 2012. A percentage of 46.8 of studies regarding SLAP tears were level 4 evidence and expert opinion made up 14.6% of SLAP tear literature (figure 6).

SLAP tear literature has been published in a variety of journals. A percentage of 47.7 of SLAP tear literature was published in orthopaedic surgery journals. A percentage of 79.1 of SLAP tear literature published in orthopaedic surgery journals was related to operative treatment of SLAP pathology. A percentage of 30.9 of SLAP tear literature was published in general medicine journals. A percentage of 14.9 of SLAP tear literature was published in radiology journals. A percentage of 5.5 of SLAP tear literature

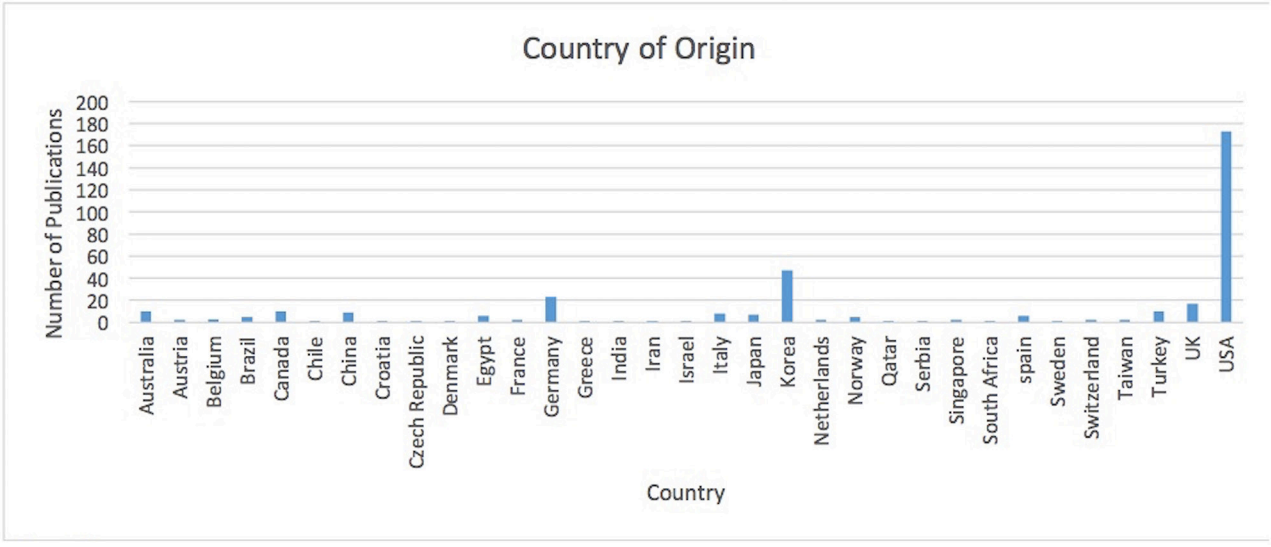

Figure 2 Number of publications regarding superior labrum from anterior to posterior pathology by country.

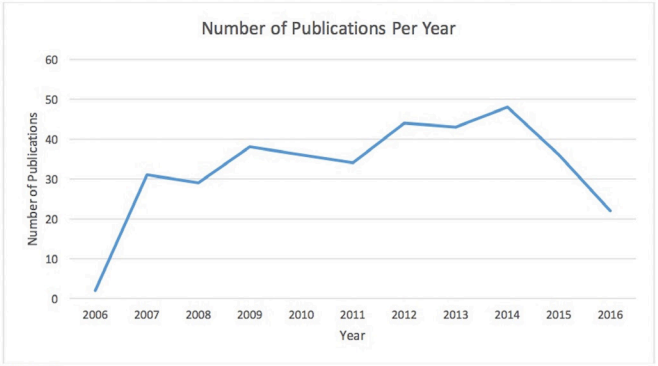

Figure 3 Number of publications regarding superior labrum from anterior to posterior pathology by year.

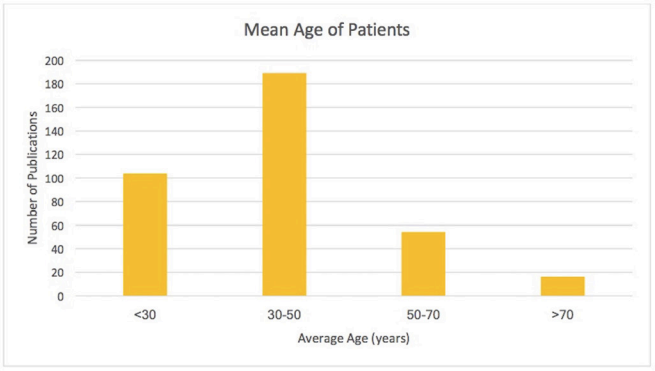

Figure 5 Distribution of superior labrum from anterior to posterior tear publications by mean age.

was published in other types of journals, not mentioned above (figure 7).

Reported treatment

A percentage of 62.5 of studies examined operative intervention for SLAP tears, with only 37.5% of SLAP tear studies examining non-operative treatment. This proportion of studies examining operative intervention was similar for all countries that produced more than 10 publications during the study period with no statistically significant differences. The population of patients undergoing operative management was 31.5±6.9 years, with those undergoing non-operative management averaging 39.3±8.8 years (p=0.09). The majority of literature describing operative intervention of SLAP tears was produced in the USA (58.5%), followed by Korea (19.1%) and Germany (9.8%). Only two studies in our database (one prospective study) compared biceps tenodesis/tenotomy and SLAP repair for patients with type 2 SLAP pathology. We were unable to identify any randomised controlled trials that compared biceps tenotomy/tenodesis with SLAP repair for type 2 SLAP pathology during the time period reviewed.

Reported complications

Complications were reported in 25.3% (92/363 studies) of published papers. A percentage of 32.6 (30/92) reported post-operative pain as the primary complication, with the incidence ranging from 10.4% to 39.1%. This is followed by stiffness and decreased range of motion (30.4%, 28/92 studies), with the incidence ranging from 3.9% to 20.0%. Hardware failure was reported in 16.3% (15/92) of papers, with an incidence ranging from 2.5% to 15.0%. Nerve/brachial plexus injury was reported by 13% (12/92) of published literature, with an incidence ranging from 2.0% to 6.3%. Only 7.6% (7/92) papers reported infection as a complication of SLAP repair (incidence 2.2%–6.5%) (table 2).

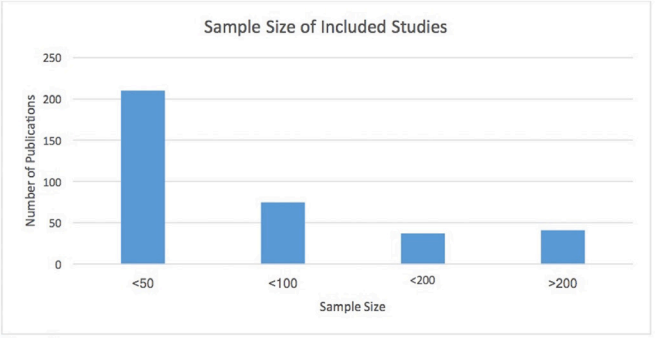

Figure 4 Distribution of superior labrum from anterior to posterior tear literature by sample size.

DISCUSSION

Key findings

This systematic review of SLAP literature brings to light a number of key findings. The majority of patients in whom SLAP outcomes are reported involve young males. Our review found 76.1% of patients with SLAP pathology in the literature were male. We also found across the literature a mean age of 34.6 years with 23.7% of studies reporting a mean age between 20 and 30 years. Only 18.5% of studies reported SLAP pathology in patients between the age of 40 and 50 years. Our review also identified a trend towards operative intervention for SLAP pathology in patients who are younger than those who were treated with conservative measures. This may reflect that a number of throwing sports involve primarily male athletes. Due to this overhead athletic participation, the young male patient may be more affected by the physical limitations of a SLAP tear and may have a strong need/desire for treatment. The acute mechanism of SLAP tears in younger patients, compared with a primarily degenerative aetiology in an older demographic, may also prompt the younger patient to seek evaluation more commonly and urgently and desire operative intervention. In addition, this gender/age discrepancy could reflect physician bias towards examining SLAP pathology in a younger male demographic for the above-mentioned reasons. This review suggests that SLAP pathology in older patients may be under reported as it is not an uncommon clinical problem in our practice. Furthermore, there is significant controversy regarding operative

Table 1 Reporting of outcome scores in superior labrum from anterior to posterior tear literature

Clinical outcome score reported	Number of publications (%)
American Shoulder and Elbow Surgeons	62/219 (28.3)
Visual Analogue Scale	49/219 (22.4)
Constant	32/219 (14.6)
University of California Los Angeles	23/219 (10.5)
Rowe	18/219 (8.2)
Western Ontario Shoulder Instability Index	10/219 (4.6)
Disabilities of the Arm, Shoulder, and Hand	10/219 (4.6)
Short Form	9/219 (4.1)
Kerlan Jobe Orthopedic Clinic	6/219 (2.7)

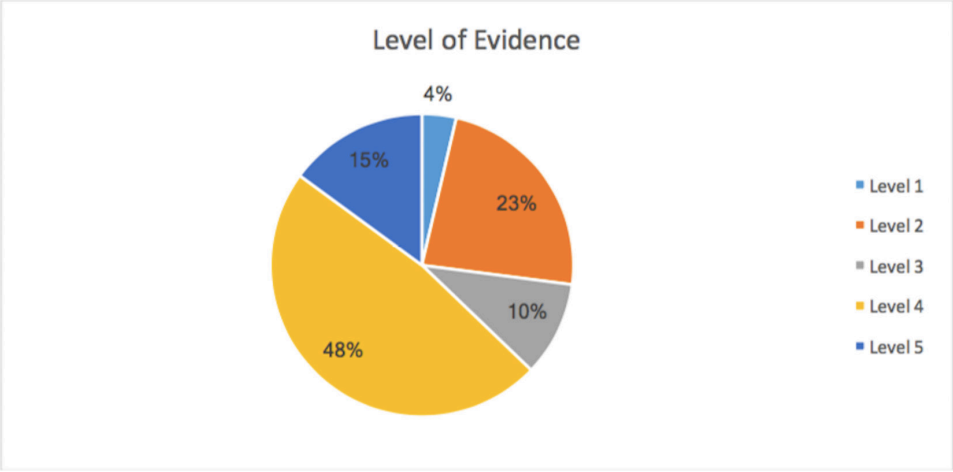

Figure 6 Distribution of superior labrum from anterior to posterior tear literature by level of evidence.

management of type 2 SLAP pathology in this demographic, with little clinical information to definitively support biceps tenotomy/tenodesis or SLAP repair. This demonstrates the need for more clinical studies reporting on the operative management of SLAP pathology in older (age >40 years) patients with failure or non-operative management.

Outcome reporting was widely present in the literature with over 60% of all SLAP literature reporting at least some form of clinical outcome score. The most common was the ASES score, which was reported by 28.3% of all studies that reported clinical outcomes. This is encouraging as the ASES has been reported to have good reliability, validity and high responsiveness for assessment of shoulder function.[7] It allows for patient self-evaluation through 11 items that can be used to generate a score, divided into two areas: pain and function. We found patient satisfaction scores were the least used outcome, with only 15.4% of publications reporting this outcome. Increased focus on including patient satisfaction in outcome reporting may provide additional focus on patient important outcomes. With regards to complications, we found 25.3% of the studies included in our review reported complications related to SLAP tear surgery. The most commonly reported involved continued pain post operatively followed by stiffness and decreased range of motion. Clinicians managing SLAP pathology through surgical intervention should caution patients regarding these widely reported risks. This scoping review found limited comparative literature to inform clinicians, regarding the use of biceps tenodesis or tenotomy in patients presenting with type 2 SLAP lesions.

We found the majority of research related to SLAP pathology was produced in North America (50.5%) particularly with regards to operative management, where 58.5% of research was published by researchers in the USA. This is very similar to global demographic trends seen in other areas of orthopaedic research.[8–10] This may be related to a variety of factors that influence output of surgical publications, including availability of research resources, research spending, healthcare infrastructure, level of activity/recreation and proficiency in the English language.[11 12] While the reasons for this bias towards North American research likely involve the aforementioned factors, interest from orthopaedic journals regarding operative outcomes may also play a role. Our results demonstrate that 79.1% of SLAP tear literature published in orthopaedic surgery journals was regarding operative management. It is also possible that this clinical phenomenon and subsequent surgical intervention is seen primarily in patients from affluent and/or well-developed

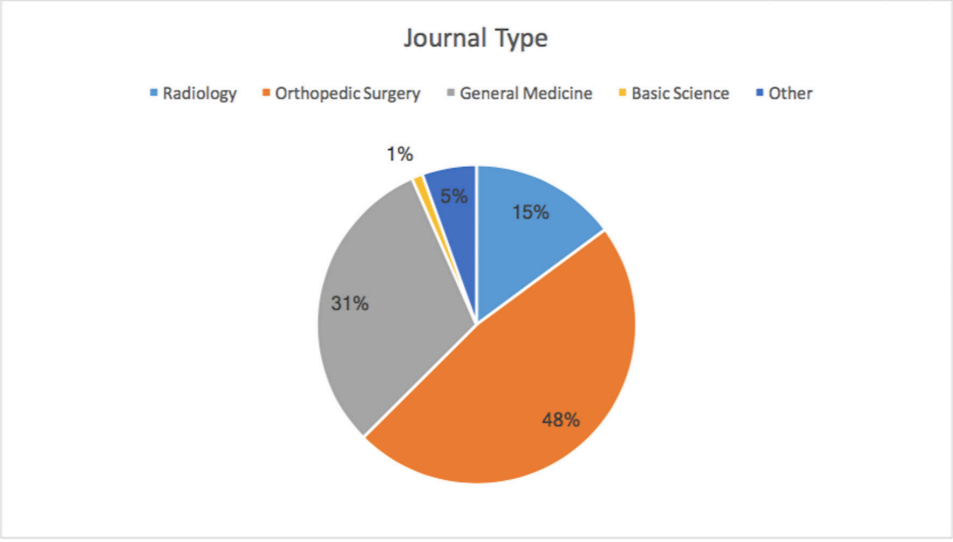

Figure 7 Distribution of superior labrum from anterior to posterior tear literature by journal type.

Table 2 Reporting of complications in superior labrum from anterior to posterior tear literature

Complications	Number of publications (%)
Pain	30/92 (32.6)
Stiffness/decreased range of motion	28/92 (30.4)
Hardware failure	15/92 (16.3)
Nerve/brachial plexus injury	12/92 (13.0)
Infection	7/92 (7.6)

regions. This geographic discrepancy may also reflect the current state of innovation in SLAP tear diagnosis and treatment.

We identified the majority of publications related to SLAP pathology are of low quality of evidence with small sample sizes and study designs at high risk of potential bias in results. Of all SLAP tear literature, 71.3% of was level 3 or below. Case series level studies are predominant in the SLAP literature, comprising 44% of all studies in our review of the past decade. Only 3.6% of all literature was reported to be of level 1 quality. We found little improvement has been made in the quality of evidence over the past decade as well, with no significant increase in level of evidence over time. The majority of SLAP tear studies had a sample size of less than 40 patients (50.8%). These retrospective and/or observational studies with small sample sizes can be problematic, as they are at significant risk of bias. The findings from these studies can be difficult to interpret, as their results can often be imprecise or not adequately powered. This limits the ability to apply these findings to clinical practice and guidelines for care. Although these studies, as well as case series/reports, can be useful for hypothesis generation, it is not always possible to rely on conclusions and findings from such papers due to their inherent limitations. This review further emphasises the importance of performing methodologically rigorous SLAP tear research, including randomised control trials and other prospective studies with large sample sizes. Specifically, the treatment of type 2 SLAP tear pathology with a biceps tenotomy/tenodesis compared with SLAP repair is an important clinical question that has not definitively answered in the literature. With no large, prospective studies and no randomised controlled trials regarding biceps tenodesis/tenotomy versus SLAP repair, little quality evidence is available for guiding treatment of this common and often debilitating clinical entity.

Future focus on performing high-quality research is important to provide reliable answers to clinicians particularly with current unanswered questions of management, including the fundamental efficacy of operative versus non-operative management.

Strengths and limitations

There were several strengths to this systematic review. First, multiple reviewers were involved in the screening of studies and abstraction of data from our literature search. Furthermore, the agreement between reviewers was found to be almost perfect agreement. Second, we used a broad-based search strategy resulting in a comprehensive search of multiple databases.

Limitations of this review involve potential for English language bias given our inclusion criteria. This was done for feasibility and may be a reason for our findings of limited publications in non-English-speaking countries. In addition, a small number of the studies that otherwise may have met our inclusion criteria did not have locatable full-text articles despite an extensive search; however, this is unlikely to modify the geographic distributions found in our review.

CONCLUSION

Current literature related to the management of SLAP pathology demonstrates a predominance of North American studies with low levels of evidence consisting of small sample sizes and variability in specific clinical outcome score reporting. Future research should focus on multicentre, randomised studies to clarify current controversies in the management of SLAP pathology, including the fundamental efficacy of non-operative and operative management.

Contributors NKB and AB: substantial contributions to the conception or design of the work and the acquisition, analysis and interpretation of data for the work. NKB, MK and AB: drafting the work and revising it critically for important intellectual content. All authors: final approval of the version to be published. All authors: agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. MK: substantial contributions to the conception and design of the work. JMK: revising the work critically for important intellectual content. EP, GR, PR and LT: substantial contributions to the acquisition, analysis and interpretation of data for the work.

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