

General

Knowledge Mapping of Postoperative Complications Following Shoulder Arthroplasty

Ilysa Hilliard¹ , Sofia Malik² , Latha Ganti, MD, MS, MBA, FACEP³ 

¹ Westminster Christian School, ² Washington University in St. Louis, ³ The Warren Alpert Medical School of Brown University

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Background

Although less common of a procedure than knee or hip arthroplasties, shoulder arthroplasties are an important procedure. As with all arthroplasties, shoulder arthroplasties are associated with complications. The present research aimed to investigate subject characteristics and complications in shoulder arthroplasty research using a bibliometric approach.

Methods

Publications related to shoulder arthroplasty and complications in the last 20 years from 2006 to 2025 were searched in the Web of Science database. VOSviewer, a free visualization software, was used to analyze the results.

Results

Bibliometric analysis revealed 3735 records. The United States contributed the highest number of publications, followed by France and Germany. The most relevant institutions were the Mayo Clinic in Rochester, Minnesota and the Hospital for Special Surgery in New York City. The most productive journal was the Journal of Arthroplasty. The top keywords include “complications” with 753 occurrences, “arthroplasty” with 526 occurrences, “outcomes” with 463 occurrences, and “prosthesis” with 385 occurrences.

Conclusion

The current study observed an increasing trend of research papers in shoulder arthroplasty complications. Institutions from the United States were found to dominate the field. An increase in clinical research and information about rehabilitation strategies following shoulder arthroplasties will prove to be advantageous for trainers, physicians, and orthopaedic surgeons alike.

HIGHLIGHTS

- Institutions from the United States, particularly the Mayo Clinic and the Hospital for Special Surgery dominated the field of shoulder arthroplasty.
- The present study demonstrated an increasing trend of research papers in shoulder arthroplasties
- An increase in clinical research and information about rehabilitation strategies following shoulder arthroplasties will prove to be advantageous for trainers, physicians, and orthopaedic surgeons alike.

INTRODUCTION

It is estimated that an average total of 943,000 arthroplasties will occur by the year 2030.¹ An arthroplasty is medically defined as the replacement of any joint with artifi-

cially produced material. The two types of arthroplasties include total and partial; total arthroplasties concern the resurfacing of all articular surfaces, while a partial arthroplasty concerns one or some joint surfaces. Of these surgical procedures, shoulder arthroplasties are some of the least common and, consequently, least studied.

Complications or risks of arthroplasties include inflammation, nerve damage, postoperative bleeding or injury of blood vessels, dislocations after surgical processes, calcification of tissue, or persistent discomfort. Periprosthetic joint infections (PJIs) are an additional complication that contributes to an increased mortality risk, specifically in hip and knee procedures. As a result of these risks and complications, it is not unusual for a patient to undergo repeat or revision surgery following prior surgical procedures to the problem area. However, shoulder arthroplasties see the least amount of repeat surgeries compared to hip and knee replacements.²

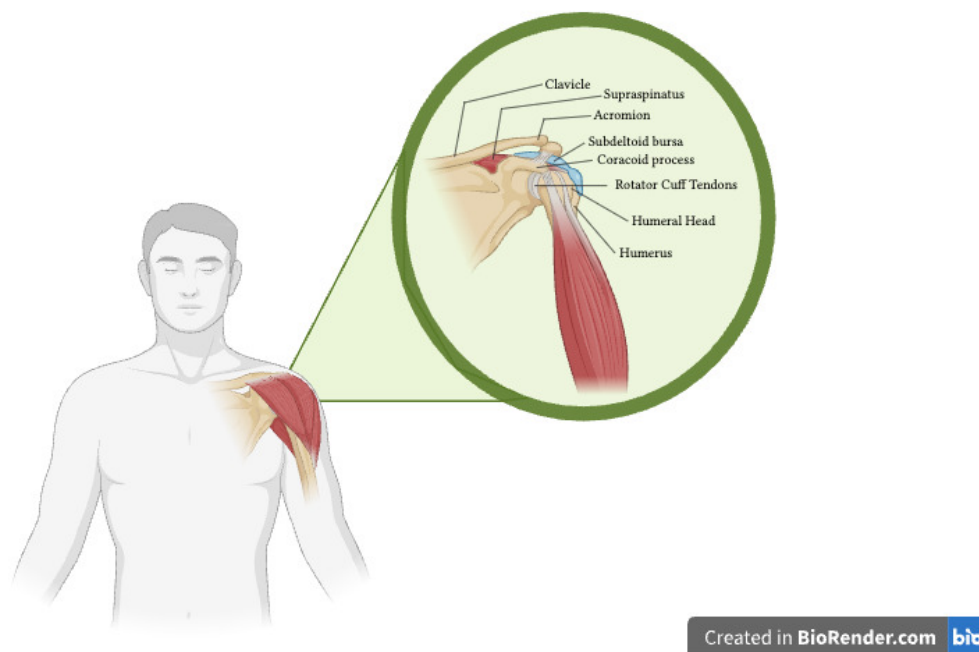


Figure 1. Anatomical View of the Shoulder. Figure created by Ilyssa Hiliard using BioRender® software.

A shoulder arthroplasty replaces the humeral head and glenoid socket of the shoulder with an artificial attachment. Injuries and complications such as subscapularis dysfunction or failure, inflammatory arthritis in the glenohumeral region, and multiple types of humeral fractures are indications of a necessity for a shoulder arthroplasty.^{3,4} Arthroplasty procedures are used to treat and reduce patients' obstinate arthritic pain and resurface humeral head fractures.⁵ This procedure also provides relief in the case that the humeral sector is exposed to trauma or infection.

Themistocles Gluck, a German physician, is recognized as an early pioneer of the shoulder arthroplasty, with the earliest design dating back to the late 1800s. The first procedural account, however, occurred in 1893 and was attributed to French surgeon Jules Emile Péan.⁶

Now, multiple approaches to these arthroplasties and implant options exist such as total shoulder arthroplasty (TSA), reconstruction of the humeral head, and reverse shoulder arthroplasty (RSA).⁷ TSA procedures and shoulder arthroplasties are common with those who participate in activity or athletic leisure in their everyday lives. Some benefits of this procedure are the highest patient return rate to sports and a satisfactory performance with an intact rotator cuff that is affected by primary glenohumeral osteoarthritis (PGHO).^{8,9} Specifically, posterior TSA, in comparison to traditional TSA, is more effective regarding long-term rotator cuff complications.⁴ In contrast, RSA is the most widely used procedure for most massive rotator cuff tears (MCTs) and is a plausible treatment option for irreversible MCTs.¹⁰ Additionally, the RSA procedure has become increasingly popular over TSAs in patients both overall and with PGHO.⁹ In comparison, TSA leads to more complications while RSA leads to lower functional outcomes.¹¹

METHODS

A bibliometric analysis is defined as a method of identifying patterns and trends in a particular field of study. These patterns include information pertaining to citation data, authorship and co-authorship details, and records of publication, all comprehensively sourced from reliable databases such as Web of Science or PubMed. This data is then used to illustrate the structure and networking of a specific field of study, including the organizations, historical data, and subdivisions of a broad study. The visualization of this data can be obtained through online applications and programs such as VosViewer®, CiteSpace®, Biblioshiny® and several other programs, allowing researchers to conceptualize the connection of thousands of data points at one time with minimal effort. In this analysis, data from 3,735 documents was synthesized into a myriad of graphs and network visualizations, with information regarding key words of related documents, network visualizations of the most prominent organizations in this field of study, and the distribution of literature about this topic over every country with a publication.¹² As this research does not involve human subjects, IRB review was not required by the corresponding author's institution. Further, this research meets the National Institutes of Health criteria for exempt research.

RESULTS

PUBLICATION YEARS

In the last ten years, the number of publications and literature on complications and limitations of shoulder arthroplasties has increased greatly, with 2023 being the

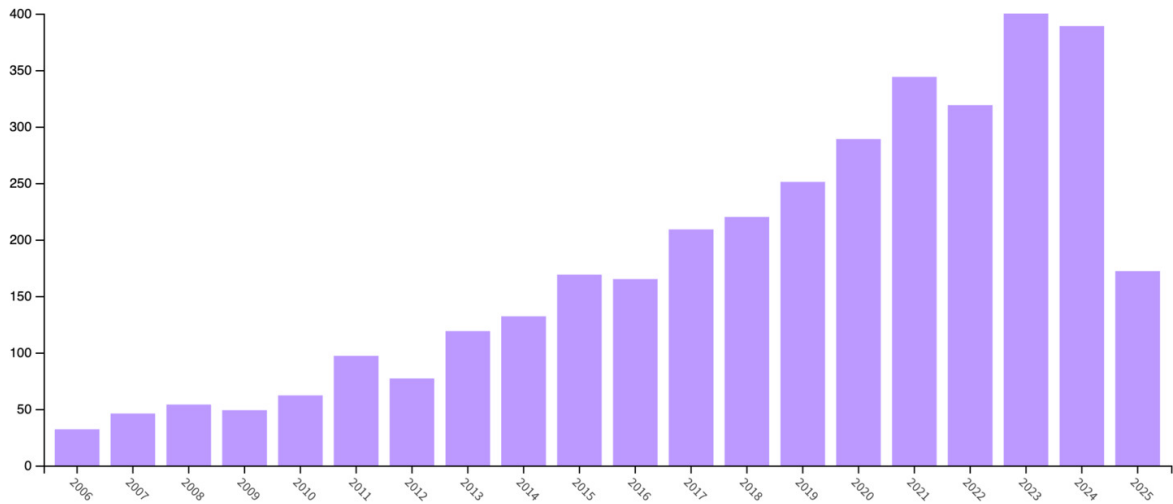


Figure 2. Bar Graph Portraying the Number of Publications on Shoulder Arthroplasties Produced Per Year from 2006-2025.

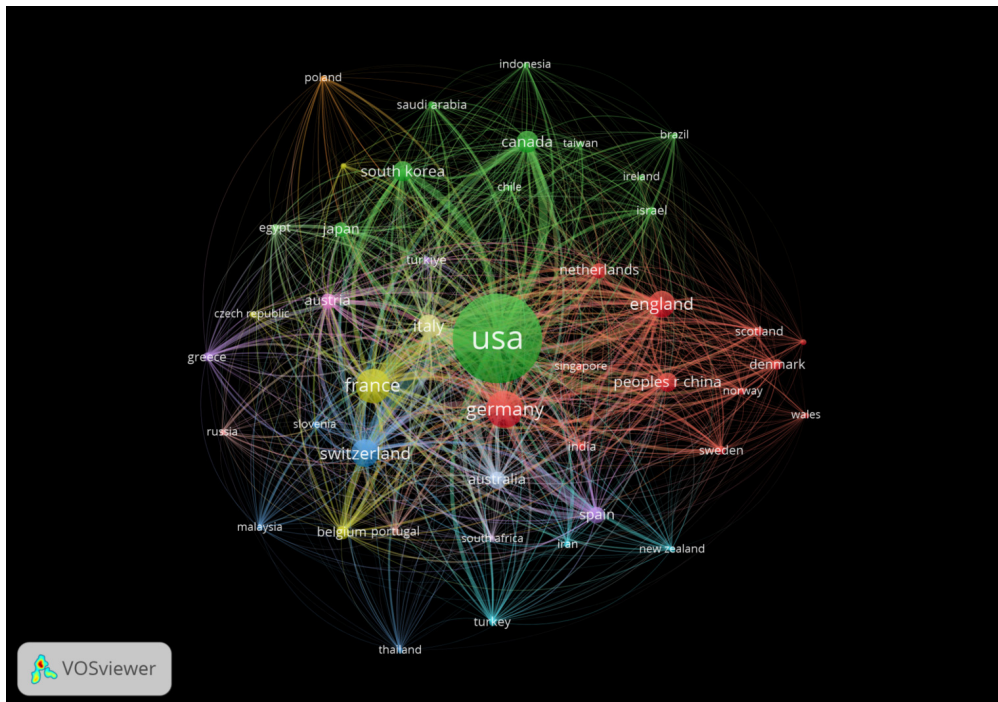


Figure 3. Countries Publishing Documents on Shoulder Arthroplasties.

year with the greatest amount (Fig. 1). As the trend shows an increase in research and published literature, the number of publications for 2025 is predicted to be within the 325 to 400 range.¹³

COUNTRIES

The majority of publications in this field come from the United States, preceding Germany and France. The United States was the leader in publications with 1,204 out of

3,735. Germany produced 212 and France has 186. This shows a disparity in the distribution of knowledge in this field of study, as the concentration of literature is mostly in the United States. Figure 2 depicts the disparities between the research in the United States and the studies in other countries.

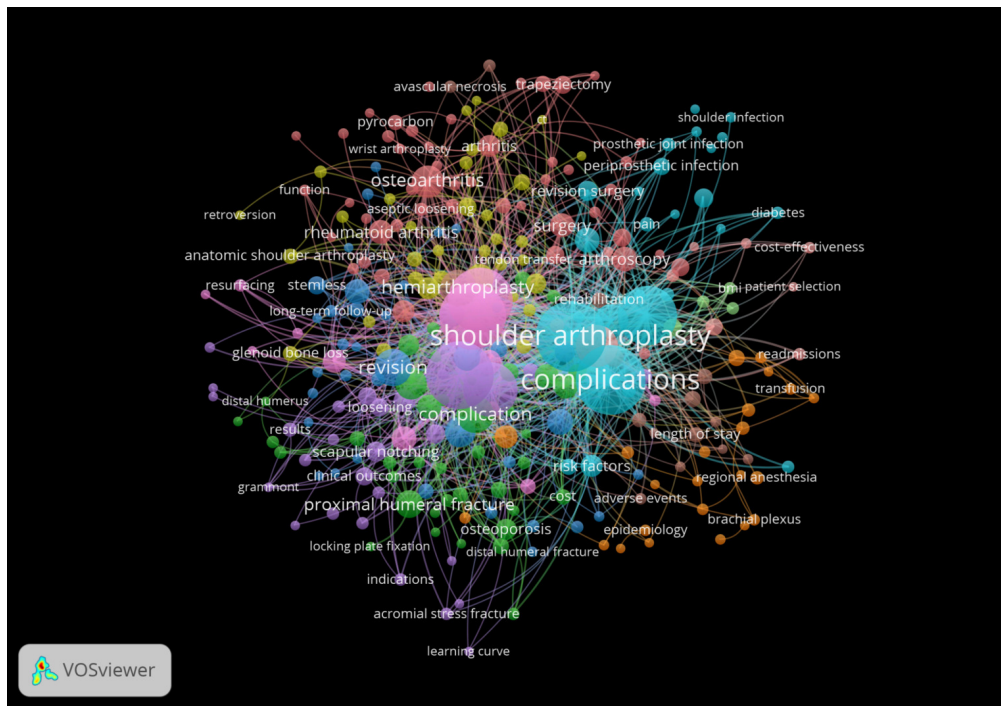


Figure 4. Prominent Keywords Found in Shoulder Arthroplasty Publications.

KEYWORDS

The top keywords include “complications” with 753 occurrences, “arthroplasty” with 526 occurrences, “outcomes” with 463 occurrences, and “prosthesis” with 385 occurrences. The study of complications in shoulder arthroplasties is limited, but vast in its potential to connect to many other subdivisions of medicine. For example, a somewhat prominent keyword is “tranexamic acid,” which is a medication used to hinder the development of blood clots, which exemplifies the outreach of this research.

ORGANIZATIONS

The top organizations with publication citations include Mayo Clinic, Hospital for Special Surgery, Rush University, and the University of Florida. These top organizations have a vast outreach, as the link strength between them is an average of 1,051. This signifies how many other organizations reference these four, demonstrating these organizations' proficiency in the area of research. Specifically, Mayo Clinic has 140 document citations spread over 100 different organizations, which attributes to their remarkable link strength of 1,672. As a result, it is more than likely that the publications from Mayo Clinic are cited by other organizations.

DISCUSSION

A bibliometric analysis of 3,735 documents demonstrated the trends and connections between different divisions under the key topic of shoulder arthroplasties. The analysis comprehensively reported data in various subjects such as authorship, organization citations, countries of publica-

tions, and publication years. This analysis is crucial in the future of shoulder arthroplasty complication research.

Many keywords were found to be connected to the topic, as shown in [Figure 3](#). These keywords range from broad to very specific, all pertaining to the overarching procedure of a shoulder arthroplasty. One keyword is “tranexamic acid” used as a treatment for blood clotting. In some cases, a complication of the healing process after a shoulder resurfacing can include calcification of blood in the humeral area. Tranexamic acid bonds to a site in blood cells to stabilize existing blood clots, reducing overall blood loss and lowering the need for transfusions.¹⁴ The usefulness of this medication explains the prominence of this keyword in the field of arthroplasties. The risk of blood coagulation in the affected area could uncover a new subset of research in this topic that will prove to be beneficial for those who suffer complications after surgery.

The top organizations that are cited within literature related to this topic include Mayo Clinic, Rush University, Hospital for Special Surgery, and the University of Florida. A majority of the cited organizations come from universities, which connects to the amount of NCAA Division 1 athletes needing medical care and assistance throughout their careers. The top college sports conferences, such as the Southeastern Conference (SEC), Big Ten, Atlantic Coast Conference (ACC), Big 12, and Pac 12 are home to some of the highest performing athletes in history every year. In that case, there is an increasingly higher risk of injury during the playing season and, consequently, an elevation in the likelihood of possible complications and/or injuries. In a study concluded in 2020, Janet E Simon et. al reasoned that the demands required of NCAA Division 1 athletes leads to perpetual constraints to their health-related quality of life (HROoL). Additionally, the tendency for athletes

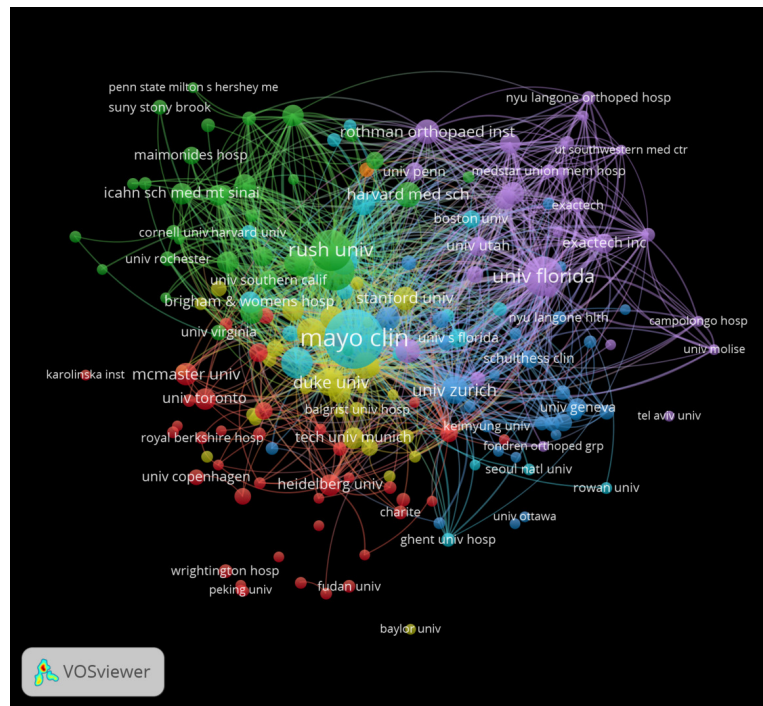


Figure 5. Organizations Publishing Documents on Shoulder Arthroplasties.

to overtrain and participate in high-intensity exercise for long periods of time puts them at increased risk of worsening an injury or contributing to deteriorating immune health. These occurrences are a result of extreme stress on the body and mind without proper care to prevent these complications in the future.¹⁵ Further, these complications apply to specific parts of the body, such as shoulders for overhead athletes. Overhead athletes are those who typically put constant force on their brachial area by throwing, catching, or lifting. These repetitive overhead movements can induce a pain pattern that may never be resolved. Superior labral anterior-posterior (SLAP) injuries or equivalents may be a result of these pain patterns, leading to shoulder instability that may require a surgical arthroplasty.¹⁶ Moreover, in a 2021 study, David J Tennent et. al researched the effect of humeral and posterior instability on Division 1 National Collegiate Athletic Association (NCAA) football players. The data points collected included: the amount of those players to undergo surgery, loss of playing time, and the rate of recurring instability in the same areas. Of ten United States Military Academy football players who suffered posterior injuries, seven were able to return within one week of injury, but five sustained recurring injury or discomfort. Seven of the athletes underwent surgical procedures during the postseason period, and only four returned to play football. This study illustrates the likelihood of athletes requiring shoulder procedures or arthroplasties after suffering from posterior glenohumeral instability, and how this indicator is common in many athletes, especially football players.¹⁷ Literature building off of the aforementioned study, written by Blake M Bodendorfer, documents the connections between athletic activity and posterior shoulder instability. These maladies are most commonly reported in young military cadets and collegiate players eligible for the

National Football League Draft. Shoulder instability is also most commonly apparent in those who are football linemen, overhead athletes, weightlifters, gymnasts, and active-duty service members. This instability may be treated surgically or nonsurgically depending on the severity. However, in the majority of cases, shoulder instability as a result of athletic injury results in surgical treatment.¹⁸

Many complications may arise from this type of procedure, such as infection in the affected area, calcification of muscle tissue, or new or worsened osteoarthritis. Specifically, complications after RSA include humeral dislocation and baseplate failure following surgery, typically resulting in the need for an implant modification.¹⁹ Osteoarthritis is the most common complication following surgery and is characterized by symptoms of degenerative changes near the humeral head and is catalyzed by repeated participation in high-intensity sports. It radically affects the range of motion and flexion of the shoulder, dramatically reducing patients' quality of life. The connection between vigorous sport athletic activity and the development of osteoarthritis is not wholly understood, leaving room for the development and growth of this research. However, by analyzing the correlation between osteoarthritis and pre-professional and professional sports, the need for shoulder arthroplasties can be dramatically reduced. Furthermore, due to the severe disparity of research regarding rehabilitation programs and approaches following an ATSA procedure, study in this field would prove to be able to prevent symptoms of shoulder arthroplasties and complications after.

LIMITATIONS

There are limitations to this analysis such as publication bias, language bias, selection of databases, and search bias.

This analysis was done within the scope 20 years, severely limiting the amount of insight provided by literature before the year 2006. Additionally, every document was written and read in English, restricting data points from other countries' views and research. Only the Web of Science database was used to collect documents and create figures and connections. Further, the keywords used in that search and other searches across the PubMed index were specific, and MeSH terms were not used in the search process.

CONCLUSION

In this bibliometric analysis, data was comprehensively analyzed in order to compare trends within the umbrella of complications following a surgical shoulder arthroplasty.

With the United States being the leading country in publications and the Mayo Clinic being the foremost cited organization, the proficiency and vastness of knowledge in this topic is concentrated in the United States. An increase in clinical research and information about rehabilitation strategies following shoulder arthroplasties will prove to be advantageous for trainers, physicians, and orthopaedic surgeons alike.

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