ISSN 2706-6819 Vol.7, Issue 2: 46-56, DOI: 10.25236/IJFM.2025.070208

Global Trends in the Diagnosis and Treatment of Knee Valgus after THA: A Bibliometric and Visualized Study

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Abstract: *Knee varus can cause pain during walking in the knee joint, and the joint's mobility is also affected, which can easily lead to knee osteoarthritis. This study aims to explore the current status and trends worldwide regarding the diagnosis and treatment of knee varus after total hip arthroplasty (THA). Research on knee varus following total hip arthroplasty (THA) published between January 1, 2014, and January 3, 2025, was collected from the Web of Science Science Citation Index Expanded (WOS). Bibliometric techniques were employed to examine and categorize the source data. For visualization purposes, VOS viewer version 1.6.18 software was used to conduct analyses on coauthorship, cooccurrence, bibliographic coupling, and cocitation, as well as to assess the overall research trends related to knee varus after THA in recent years. 440 relevant articles in all were gathered. Both the proportional research interest and the quantity of papers produced each year are rising globally. A logistic growth model can be fitted using the cumulative publication number of studies on knee varus following THA: f(x) = a/(1 + eb cx). With the highest citation counts, hindex, and total link strength (TLS), the US has made the biggest contribution to international research. "Knee Surgery Sports Traumatology Arthroscopy" publishes the majority of the studies. The university that has contributed the most is Boston University. Mechanism studies, tissue engineering, clinical investigations, and mechanical studies are the four categories into which the research falls. Clinical research receives comparatively little funding. Based on current global trends, the number of articles concerning knee varus after THA is expected to continue to increase in the coming years. In this field, the United States is the largest contributor. Notably, recent hotspots include "pathogenesis," "alignment of limbs," "arthroplasty," and "total hip arthroplasty." Therefore, there will likely be more research on tissue engineering for knee varus after THA, which may inspire new clinical treatment methods for knee varus.*

Keywords: *Total hip arthroplasty; knee varus; global trends; bibliometrics; visualization study*

1. Introduction

Total hip arthroplasty (THA) can influence the biomechanics of the hip joint as well as the patient's walking pattern[1]. Knee varus deformity is one of the common coronal plane deformities of the knee, primarily caused by developmental dysplasia of the distal femoral condyle[2]. After knee varus occurs, it mainly leads to lateral subluxation of the patella, which may affect a person's movement [3-4]. In some patients with Crowe IV type developmental dysplasia of the hip, knee varus deformity remains a relatively common clinical issue after THA[5]. This study aims to analyze the current status and trends of diagnosis and treatment for knee varus after total hip arthroplasty worldwide.

As a result, it is important to provide an overview of the current research on knee varus following total hip arthroplasty (THA), predict trends, and identify promising keywords[6]. Articles are significant indicators of contributions to quantitative scientific research because they are fundamental components of scientific inquiry[7]. Bibliometric analysis facilitates the examination of information and quality metrics within research literature databases, useful for quantifying and qualitatively assessing trends in the research community during this period [6-7]. Furthermore, bibliometric analysis has gained popularity in recent years. On the other hand, bibliometrics assists researchers in acquiring vast amounts of data and utilizing it for performance evaluation in scientific research[8-9].

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2. Materials and Methods

2.1. Data Sources

The bibliometric analysis of the data source was conducted using WOS, recognized as the premier database for bibliometric research[10]. Since no human or animal subjects were no need for ethical approval[11].

2.2. Search Strategy

Papers published from January 1, 2014, to December 30, 2024, were collected from the Web of Science. The search criteria for this research included (TS=(Total Hip Arthroplasty) AND (((Knee Valgus) OR (Genu Valgum)) OR (X-shaped Legs))) AND (Language=English) AND (Document Type=All Document Types). Data from WOS were used to improve the article information for specific countries or regions[12].

2.3. Data Collection

After obtaining and examining all of the information from the WOS database, we uploaded it to Microsoft Office Mondo 2016. This included the title, publication year, author names, countries, journal name, affiliations, keywords, and abstracts. Data was separately filtered, extracted, entered, and gathered by two writers (LJY and WJ). GraphPad Prism 9 and Microsoft Office Mondo 2016 were used to manually clean and analyze the data[13].

2.4. Bibliometric Analysis

Bibliometric analysis, which uses statistical and mathematical techniques to examine vast amounts of literature or research trends, has emerged as a crucial instrument for worldwide study and research in a variety of scientific domains[14]. The functionalities of WOS were employed to describe the basic characteristics of the eligible articles mentioned above. The hindex serves as an alternative to existing metrics and is regarded as the best method for quantifying the impact of scientific research[15]. A country or scientist with a high hindex has published h publications that have been referenced at least h times. For future trends, the logistic growth model, $f(x)=a/(1+ebcx)$, shows consistent application and predictive power. Charts showing the quantity of articles over time were made with GraphPad Prism 9. The year is represented by the independent variable x, while the total number of articles is indicated by the dependent variable f(x).Microsoft Office Mondo 2016 was used to analyze annual article counts, the top 20 nations in the world, authors, institutions, funding sources, research directions, total citation frequencies, journals, average citation rates, and hindices[16]. For visual analysis of articles, VOSviewer version 1.6.18 software can be used[17], previously employed for bibliographic coupling, coauthorship analysis, cocitation analysis, and cooccurrence analysis.

3. Results

3.1. Global Publication Trends

3.1.1. Total Global Publications

Between 2014 and 2025, 440 articles fulfilled the search criteria. Most studies have been published in the past five years (276 articles, 62.7% from 20202024). There has been a significant upward trend in the annual global articles on knee varus after THA, indicating increasing attention to this research area (Figure 1a).

3.1.2. Contributions from Various Countries

Contributions have been received from 49 countries and regions. The majority of relevant articles were published in the United States. (102 articles, 23.18%), followed by China (63 articles, 14.31%), Japan (58 articles, 13.18%), Germany (36 articles, 8.18%), and South Korea (29 articles, 6.59%) (Figure 1(b) and Figure 1(c))

3.1.3. Global Publishing Trends

To forecast the number of upcoming publications, we employed a Logistic regression model to

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generate a time curve. The fitted curve shown in Figure 1d indicates that the total number of global articles is expected to rise in the years ahead.

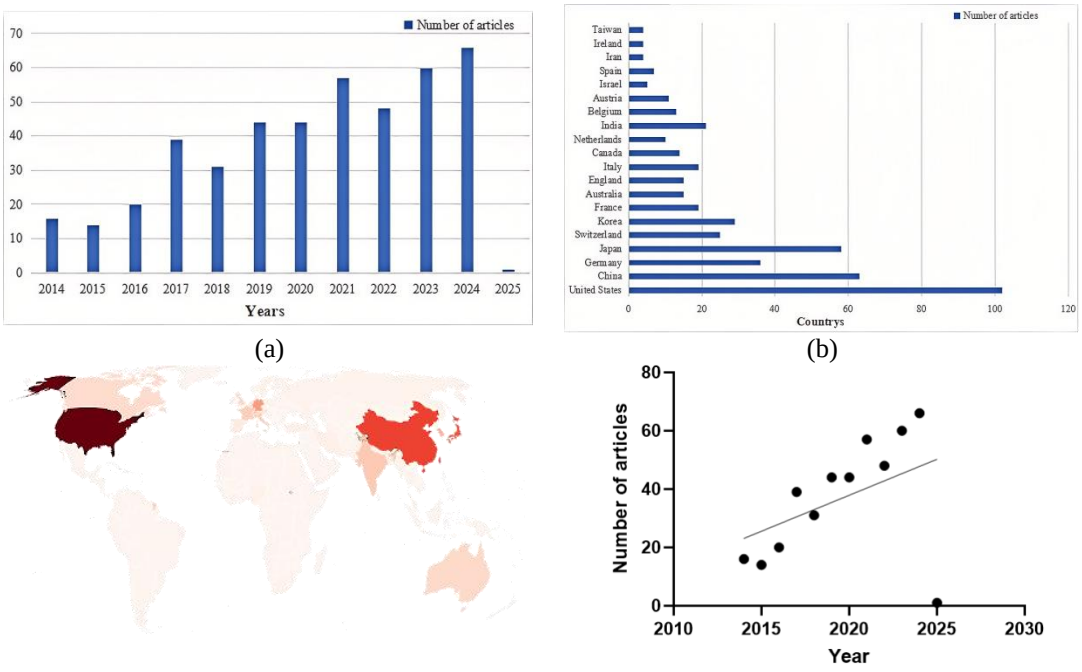

Figure 1: Global article trends related to postoperative knee valgus after THA: (a) Total number of articles related to postoperative knee valgus after THA and its related research interests; (b) World distribution map of articles related to postoperative knee valgus after THA; (c) Total number of articles related to postoperative knee valgus after THA among the top 20 countries; (d) Fitted curve predicting the growth trend of global article numbers in the coming years

3.2. Quality of Publications from Different Countries

3.2.1. Total Citation Frequency

Articles from the United States had the highest overall citation frequency. (1218). Regarding the overall frequency of citations, Germany (550), Switzerland (510), Japan (483), and England (451) ranked second, third, fourth, and fifth, respectively (Figure 2).

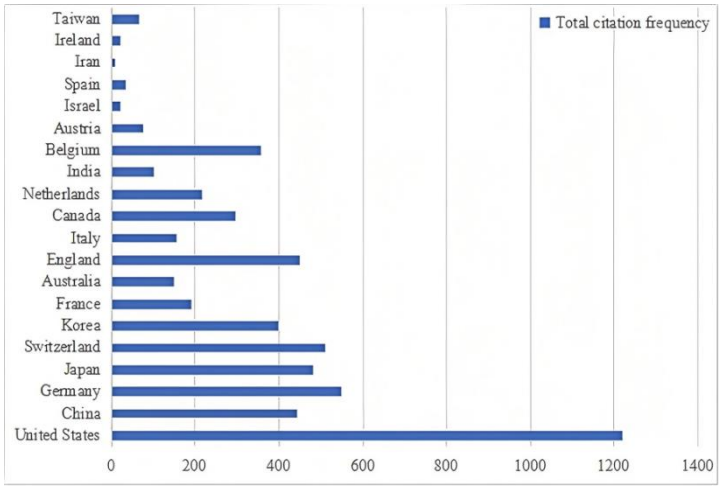

Figure 2: Total citation frequency of articles related to postoperative knee valgus after THA by country

3.2.2. Average Citation Frequency

England recorded the highest average citation frequency at 33.60. Belgium came in second with an average of 29.08, followed by Canada at 26.71, Switzerland at 23.32, and the Netherlands at 21.90 (Figure 3).

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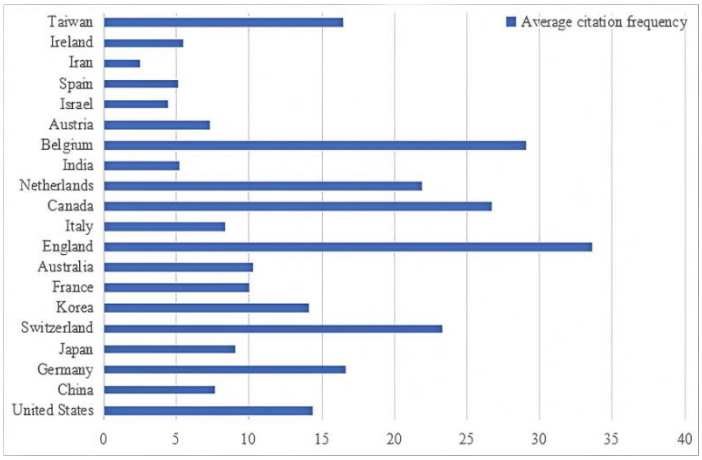

Figure 3: Average citation frequency of articles related to postoperative knee valgus after THA by country

3.2.3. Hindex

The highest hindex was found in relevant papers from the United States (20), followed by China (14), Germany (13), Switzerland (12), and Japan (12) (Figure 4).

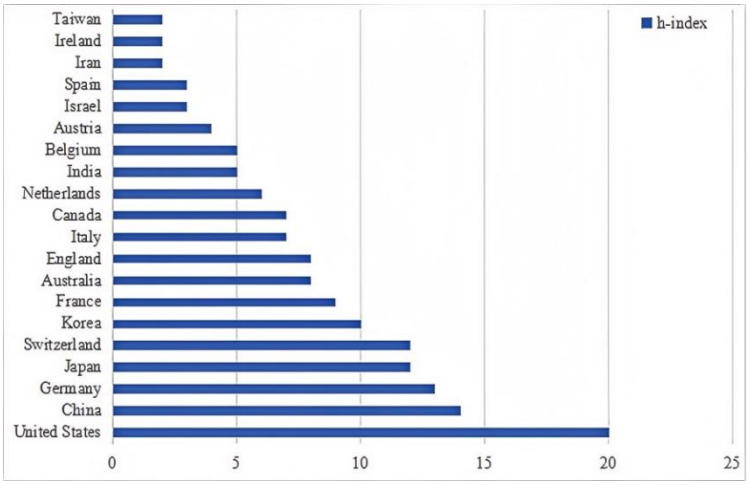

Figure 4: hindex of articles related to postoperative knee valgus after THA by country

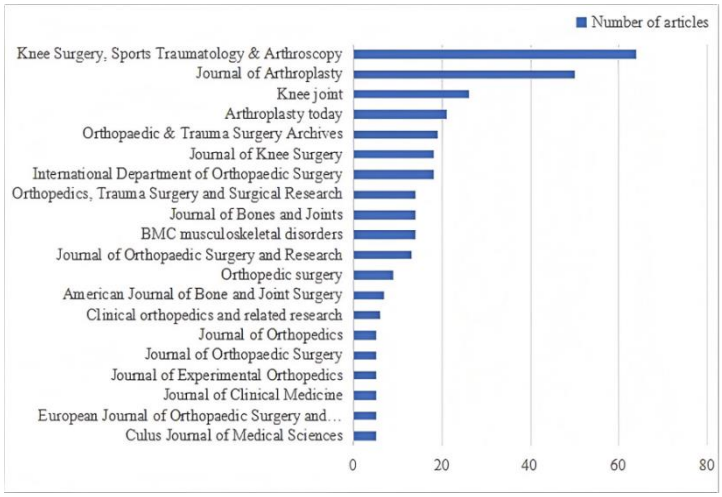

Figure 5: Number of published articles on postoperative knee valgusrelated research in the top 20 journals

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3.3. Assessment of Global Publications

3.3.1. Journal Analysis

The journal with the highest number of publications on postoperative knee valgus after THA was Knee Surgery Sports Traumatology Arthroscopy (IF= 4.704), with a total of 64 articles. The Journal of Arthroplasty (IF= 3.712) followed with 50 articles. 26 articles and 21 articles were published in Knee (IF=1.80) and Arthroplasty Today (IF=1.764), respectively. (Figure 5)Here are the top 20 journals that have published the highest number of studies.

3.3.2. Funding Sources

Figure 6 describes the top 20 funding sources. The National Natural Science Foundation of China (NSFC) funded 19 studies (ranked first), while 7 projects received no funding (ranked second).

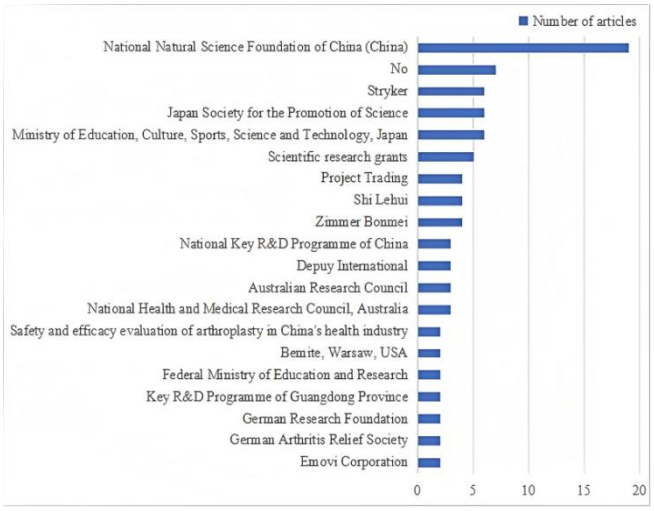

Figure 6: Number of published articles related to postoperative knee valgus research by the top 20 funding sources

3.3.3. Authors

The leading 20 authors contributed to 109 articles, which represents 24.77% of the total articles in the discipline. (Figure 7). Hirschmann, M. T. and Zhou, Zongke each published 10 and 8 articles on postoperative knee valgus after THA, followed by Sculco, Peter K. and Howell, Stephen, who published 7 and 6 articles, respectively.

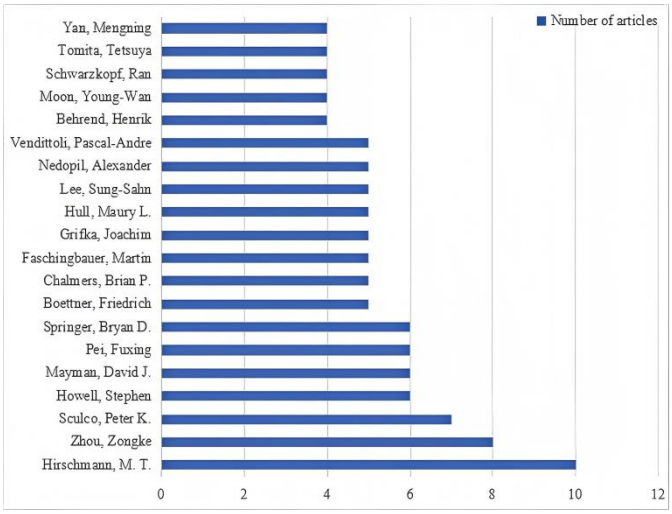

Figure 7: Number of published articles on postoperative knee valgus research by the top 20 authors

3.3.4. Publishing Institutions

The top 20 research institutions collectively published 87 articles, representing 19.77% of all

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articles in the field (Figure 8). The Special Surgery Hospital and Sichuan University published 18 and 12 articles, respectively.

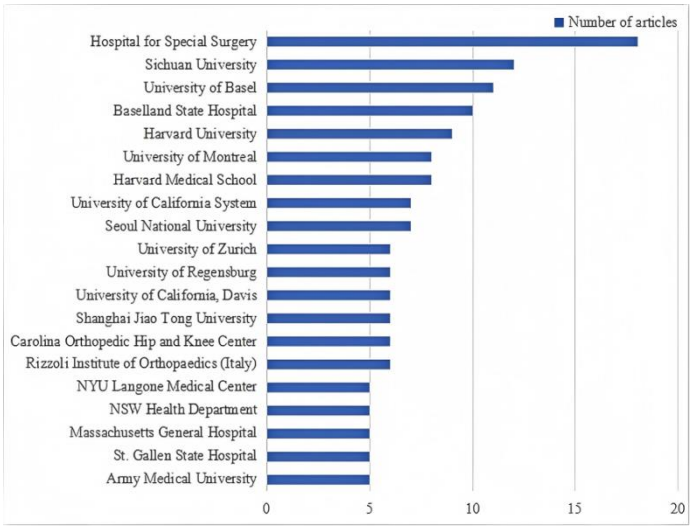

Figure 8: Number of published articles related to postoperative knee valgus research by the leading 20 publishing organizations

3.3.5. Areas of Research Focus

Figure 9 illustrates the distribution of research areas concerning postoperative knee valgus.. Orthopedics, surgery, sports science, internal medicine, and rheumatology are the the most sought-after areas of research.

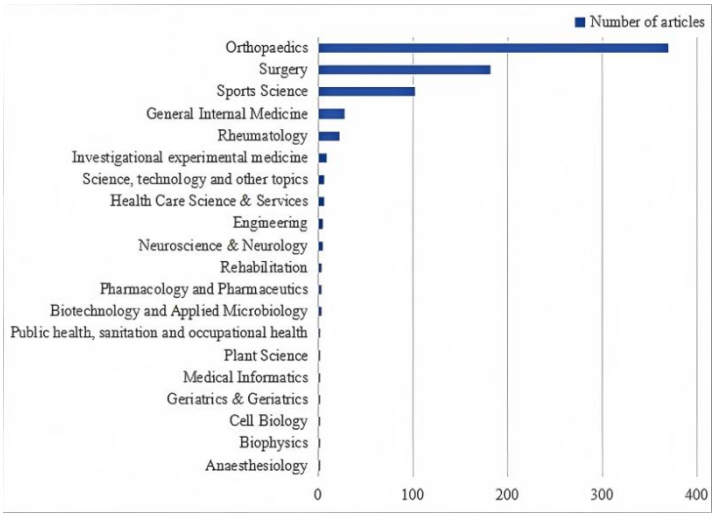

Figure 9: Top 20 research directions related to postoperative knee valgus

3.4. Bibliometric Coupling Analysis

3.4.1. Journals

VOS viewer was utilized to examine the journal titles in all articles, which were identified as those journals that appeared in more than five articles (see Figure 10a). A total of 21 elements made up the entire link strength. Knee Surgery Sports

3.4.2. Countries

VOS viewer was used to analyze papers published in 37 countries (defined as the minimum number of articles using a country more than 2 times) (Figure 10b). The United States (TLS=19075), Japan (TLS=10005), China (TLS=9193), Germany (TLS=8066), and Switzerland (TLS=6367) are the top five countries with the highest total link strength.

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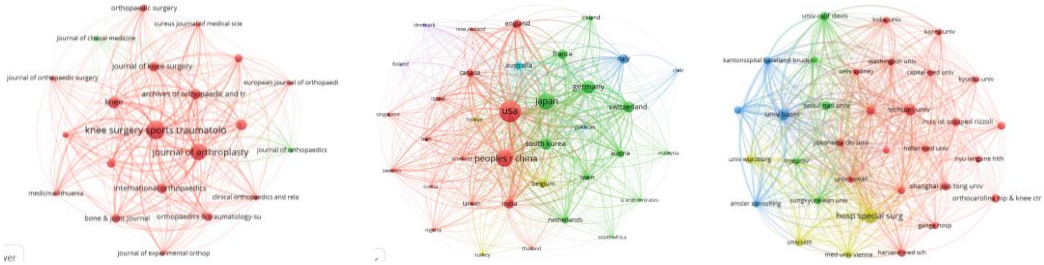
3.4.3. Institutions

Using VOS viewer, research papers published by 33 institutions were analyzed (identified as the least number of articles using an institution more than 4 times) (Figure 10c). The Special Surgery Hospital (TLS=1862), University of Basel (TLS=1698), University of California, Davis (TLL=1109), State Hospital of BaselCountry, Switzerland (TLS=1032), and McGill University (TLE=912) are the institutions with the strongest overall link strength globally.



(a) (b) (c)

Figure 10: Bibliometric coupling analysis of research on postoperative knee valgus after THA: (a) Network graph of 21 journals related to postoperative knee valgus after THA; (b) Network graph of 37 countries related to postoperative knee valgus after THA; (c) Network graph of 33 institutions related to postoperative knee valgus after THA.

3.5. CoAuthorship Analysis

3.5.1. Authors

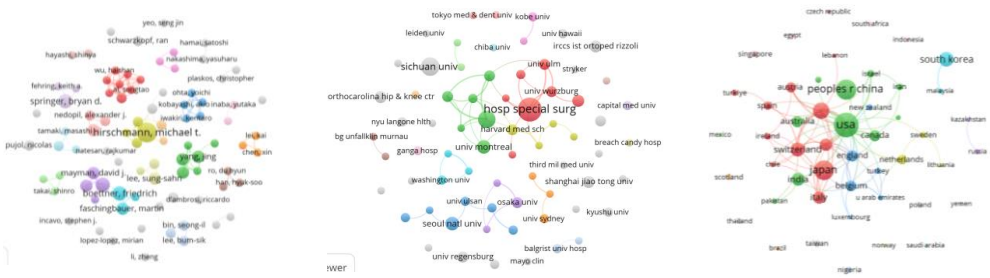
This analysis can offer useful insights for individual researchers looking for collaborators, organizing studies, and forming research groups, as well as for promoting academic exchanges between countries. VOS was utilized to analyze 87 authors, each of whom has contributed at least three articles (see Figure 11a). The top five authors, ranked by total link strength, are ai, songtao (TLS=20), han, xuequan (TLS=20), jiang, xu (TLS=20), wu, haishan (TLS=20), and xie, kai (TLS=20).

3.5.2. Institutions

Using VOS viewer, institutional research from 70 institutions was analyzed (defined as the minimum number of articles using an institution more than 5 times) (Figure 11b). University of Basel (TLS=18), Special Surgery Hospital (TLS=15), Amsler Consulting (TLS=12), St. Gallen State Hospital, Switzerland (TLS=12), and BaselCountry Public Hospital, Switzerland (TL=11) are the top five research institutions with the highest overall link power.

3.5.3. Countries

Using VOS viewer, articles from 48 countries were analyzed (defined as the least quantity of articles using a nation exceeding 5 times) (Figure 11c). The United States (TLS=45), Germany (TLS=31), Switzerland (TLS=22), France (TLS=20), and Belgium (TLS=14) are the top five countries ranked by total link strength.



(a) (b) (c)

Figure 11: Coauthorship analysis of research on postoperative knee valgus after THA: (a) Coauthorship analysis chart for 87 coauthors related to research on postoperative knee valgus after THA; (b) Collaboration analysis of THA postoperative knee valgus studies involving 70 institutions; (c) Research mapping of THA postoperative knee valgus collaboration across 48 countries

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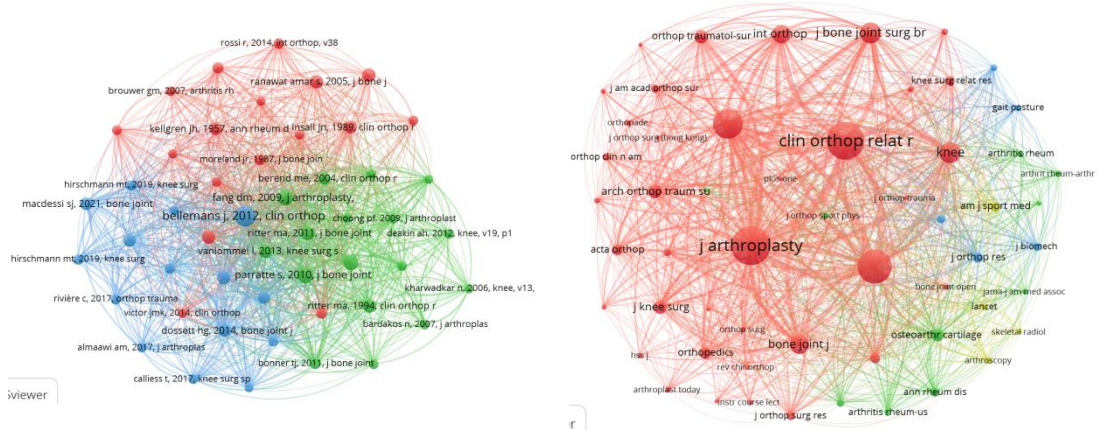
3.6. CoCitation Analysis

3.6.1. Articles

Cocitation analysis determines the significance of items by counting the frequency of their cocitation. VOS viewer was utilized to examine 49 references, which were selected based on a minimum citation threshold of over 17 times(Figure 12a). The following are the top five studies with high total link strength: bellemans j, 2012, clin orthop relat r, v470, p45; parratte s, 2010, j bone joint surg am, v92a, p2143; fang dm, 2009, j arthroplasty, v24, p39; howell sm, 2013, clin orthop relat r, v471, p1000; and vanlommel l, 2013, knee surg sport tr a, v21, p2325.

3.6.2. Journals

Using VOS viewer, the names of cocited journals (defined as a minimum citation frequency of over 27 times) were identified. As illustrated in (Figure 12b), 52 recognized journals were published within the overall connection strength. The top five journals are: Journal of Arthroplasty (TLS=37305), Clinical Orthopaedics and Related Research (TLS=37072), Knee Surgery Sports Traumatology Arthroscopy (TLS=29016), Journal of Bone and Joint Surgery American Volume (TLS=25062), and Journal of Bone and Joint Surgery British Volume (TLS=13214).



(a) (b)

Figure 12: Cocitation network diagram of knee valgus after THA: (a) A cocitation network diagram illustrating the references within the field; (b) A cocitation network diagram illustrating the relationships between journals in the field.

3.7. Cooccurrence Analysis

A total of 51 keywords were identified, roughly categorized into four main groups: “mechanism studies”, “tissue engineering”, “clinical research”, and “mechanical mechanics” (Figure 13a). In the “mechanism studies” cluster, commonly used keywords include: kinematics, osteoarthritis, progression, development, and aggravation. For the “tissue engineering” cluster, the main keywords are: arthroplasty, components, replacement, and substitutes. In the “clinical research” cluster, key terms include valgus deformity, accuracy, knee joint, knee osteoarthritis, hip, femur, lower limb, Xray photos, total hip arthroplasty, and survival rate. In the “mechanical mechanics” cluster, common keywords are axial alignment, coronal alignment, limb alignment, angles, malalignment, and angle. These results indicate that the four aforementioned areas are the most notable fields in research on knee valgus after THA.

VOS viewer color codes the keywords based on their frequency of appearance across all articles (Figure 13b). Blue signifies a prior time occurrences of keywords, while yellow indicates later occurrences. Before 2015, most research focused on the early stage of “mechanism studies.” Based on current trends, “clinical research,” “tissue engineering,” and “mechanical mechanics” are expected to receive more attention in the future.

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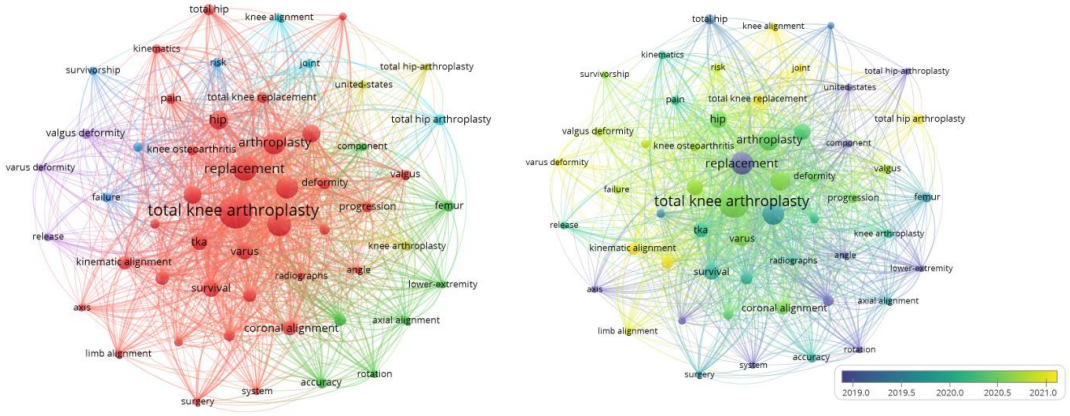

(a) (b)

Figure 13: Cooccurrence analysis on post THA research: (a) Keyword network diagram in post THA research; (b) Frequency distribution network diagram of keywords by year.

4. Discussion

4.1. Global Publishing Status and Quality

Bibliometric and visualization analyses can illustrate and forecast the present condition of the research area. Based on this study's evaluation of funding countries, institutions, funding agencies, and the focus of post THA knee valgus research, we can witness the rapid development of the field. This study shows a steady increase in the number of papers published annually. There has been a rising interest in related research in recent years. Significant studies on this topic have been published by 49 countries. We have predicted future publication volumes based on current data. Therefore, more comprehensive research on post THA knee valgus is expected in the years ahead. Considering the positive outcomes, researchers are now encouraged to conduct further highquality studies.

4.2. Trends in Research on Post THA Knee Valgus

Based on the findings from the national contribution analysis, the United States published the most articles, with KSPTA making the largest contribution. The NNSF of China ranked first in the number of papers published regarding research direction and funding support. The U.S. significantly contributes to the total number of publications on post THA knee valgus and could be regarded as a trailblazer and frontrunner in the topic in terms of total citation frequency and hindex. China holds the second position in total publications. Conversely, England ranks first in average citation frequency, and the U.S. ranks first in hindex.

Bibliographic coupling occurs when a third book is cited in the reference lists of two books. In this study, we created connections between various articles through the use of bibliometrics, analyzing from three viewpoints: journals, institutions, and countries. The core journals studying post THA knee valgus include Knee Surgery Sports Traumatology Arthroscopy, Journal of Arthroplasty, Knee, Archives of Orthopaedic and Trauma Surgery, and Journal of Knee Surgery, which are more inclined to share the most recent research advancements in this area. Moreover, Knee Surgery Sports Traumatology Arthroscopy and Journal of Arthroplasty are the journals with the most papers, indicating their leading role in international research on post THA knee valgus. Specialized surgical hospitals have the maximum overall link strength and are regarded as leading institutions in post THA knee valgus research.

4.3. Research Focus on Knee Valgus after THA

We have pinpointed the key research areas and trending subjects within this field through co-occurrence analysis[18]. A co-occurrence network map was created using all terms from the study titles and abstracts. shows four research directions, including "mechanism research," "tissue engineering," "clinical research," and "mechanical biomechanics," forming clusters. Although this finding is consistent with widely accepted knowledge in the field, this research provides clarity on potential future research paths. Keywords such as total knee arthroplasty, alignment, osteoarthritis,

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arthroplasty, and survival rate appear more frequently, with higher weights at the core of the co-occurrence map. Therefore, additional high-quality studies on knee valgus after THA are still needed in these four directions.

Overlap visualization maps are similar to co-occurrence maps, but the colors of the items differ, corresponding to the timing of their appearance; this method is particularly useful for tracking research directions. In the overlap map, colors represent publication years. Based on the study results, "mechanism research" and "mechanical biomechanics" (yellow) may become the upcoming trending subjects in this area. Consequently, including keywords such as "total knee arthroplasty," "alignment," "osteoarthritis," "arthroplasty," and "survival rate" may emerge as hot directions for knee valgus research after THA. Therefore, investigating the mechanisms of knee valgus after THA and treatments for osteoarthritis could become the main focuses of this field.

In summary, this research outlines the worldwide patterns of knee valgus following total hip arthroplasty (THA). The U.S. is the leading contributor to this area of research and is recognized as a global leader in the field. The journal Knee Surgery, Sports Traumatology, Arthroscopy has the highest quantity of articles related to this topic. It is expected that more studies on knee valgus after THA is set to be released in the next few years. In particular, research on tissue engineering for knee valgus after THA is likely to attract increasing attention and become a future research hotspot.

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ISSN 2706-6819 Vol.7, Issue 2: 46-56, DOI: 10.25236/IJFM.2025.070208

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