

# Global Research Trends of ALIF: A Bibliometric and Visualization Study

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**Abstract:** The research on Anterior lumbar interbody fusion (ALIF) has received increasing attention. This study aims to investigate the global current situation and trends in this field. The publication volume of literature related to ALIF from January 1, 1900 to November 18, 2024 was retrieved from the Web of Science-Science Citation Index Expanded. The source data were studied and indexed using bibliometric methods. For the visualization study, co-authored, co-occurrence analysis, bibliographic coupling and co-citation analysis were conducted using VOSviewer version 1.6.19 software, and the overall trend of ALIF studies in recent years was analyzed. A total of 3,414 articles were retrieved. The number of global research and publications on ALIF is increasing every year. The United States has made the highest contribution to global research in the field of ALIF, with the most citations and the highest H-index. Lippincott Williams & Wilkins and Elsevier have the highest number of publications. national natural science foundation of china (nsfc) of the united states, medtronic of the united states, national institutes of health of the united states the nih usa and the united states department of health and human services are the four institutions that have made the greatest contributions. The research fields mainly focus on three categories: clinical neurology, orthopedics and surgery. Based on the current global research trends, it is predicted that the number of publications related to ALIF will continue to increase. At present, the United States is the largest contributor to research in this field. Most research efforts will focus on clinical studies such as the clinical efficacy of ALIF surgery, which may be the next hot spot in the field of ALIF research.

**Keywords:** Anterior lumbar intervertebral fusion Surgery; Global trends, Bibliometrics, Visualization research

## 1. Introduction

Anterior lumbar interbody fusion (ALIF) is a well-known surgical technique. Many spinal surgeons use it to treat various degenerative lumbar lesions and has become a widely accepted surgical technique for various degenerative diseases of the lumbar spine<sup>[1]</sup>. The advantage of ALIF lies in its ability to the anterior intervertebral disc space without opening the spinal canal or nerve foramen. This increases the possibility of placing as large a fusion device as possible without the risk of neural structure damage<sup>[2]</sup>. The drawback of ALIF is the additional path and related complications. The most common complication is due to vascular injury. The incidence of complications in revision surgery has increased significantly. The ALIF technique meaningfully expands the skill range of spinal surgeons, especially for treating patients with nonunion after intervertebral fusion, exponential epidural scar tissue and spinal infection<sup>[3]</sup>. At present, there are still controversies regarding the clinical and prognostic aspects of ALIF. Different surgical procedures in LIF have their own advantages and disadvantages. The specific plan should be based on the patient's condition and the surgeon's experience, strictly grasping the surgical indications. The specific plan should be determined based on the patient's condition and the surgeon's experience, and the surgical indications should be strictly followed for individualized selection<sup>[4]</sup>.

However, the global development trend of ALIF has not been fully studied<sup>[5]</sup>. Therefore, it is necessary to summarize the current status of ALIF research and predict promising keywords and trend directions. Publications, as the core component of scientific research, are an important indicator for measuring research contributions. Bibliometric analysis can provide information based on literature databases and bibliometric characteristics, which is used for qualitative and quantitative assessment of the changing trends of research activities over time<sup>[6]</sup>. It provides a way to grasp the development of a certain field and compare the contributions of scholars, journals, institutions and countries. Bibliometric analysis is also used to formulate policies and clinical practice guidelines<sup>[7]</sup>. This feasible method has been successfully applied to assess research trends in osteoarthritis, hypertension, diabetes and injury. To our knowledge, the quantity and quality of research in the ALIF field have not yet been reported<sup>[8]</sup>. Therefore, the aim of this study is to assess the current research status and global trends of ALIF<sup>[9]</sup>.

## 2. Materials and methods

### 2.1 Data source

Bibliometric analysis of data sources was conducted based on the Web of Science-Science Citation Index Expanded (WOS), which is regarded as the best database for bibliometrics<sup>[10]</sup>.

### 2.2 Search strategy

In this study, the search terms are as follows: subject = (Anterior lumbar interbody fusion) and publication year = (1900-01-01-2024-11-18) and language = (English) and document type = (paper).

### 2.3 Data collection

Complete detailed information (including title, publication year, author name, country, journal name, affiliation, keywords and abstract) was obtained and analyzed from the WOS database and uploaded to Microsoft office mondo 2016. The two authors (GYH and LHL) independently filtered and extracted, input and collected data. The data in Microsoft office mondo 2016 and GraphPadPrism 9 were manually cleaned and analyzed.

### 2.4 Bibliometric analysis

Bibliometric analysis has become an important tool for global analysis and investigation in various scientific fields, and a large number of literatures or research trends have been analyzed using mathematical and statistical methods<sup>[11]</sup>. The WOS function has been used to describe the basic characteristics of the above-mentioned qualified articles<sup>[12]</sup>. Bibliometric analysis has become an important tool for global analysis and investigation in various scientific fields, and a large number of literatures or research trends have been analyzed using mathematical and statistical methods [11]. The WOS function has been used to describe the basic characteristics of the above-mentioned qualified articles<sup>[13]</sup>. logistic growth model:  $f(x)=a/(1+eb-cx)$  It has stable applicability and the ability to predict future trends<sup>[14]</sup>. Create a chart showing the number of publications over time using GraphPadprism9<sup>[15]</sup>. The independent variable  $x$  represents the year, and the dependent variable  $f(x)$  represents the total number of publications. The number of annual publications, the top 20 countries globally, authors, institutions, funding agencies, research directions, total citation frequency, journals, average citation frequency and H-index were all checked using Microsoft office mondo 2016<sup>[16]</sup>. For the visual analysis of publications, the VOSviewer software (VOS) can be used, which was previously applied to bibliographic coupling, co-citation analysis, co-occurrence analysis and co-authorship analysis<sup>[17]</sup>.

## 3. Result

### 3.1 Trends in global publications

#### 3.1.1 The total number of global publications

From January 1, 1900 to March 1, 2023, a total of 3,414 articles met the search criteria. Most of the studies were published between 2010 and 2024 (2,560 items, 74.9%), examining the annual publication

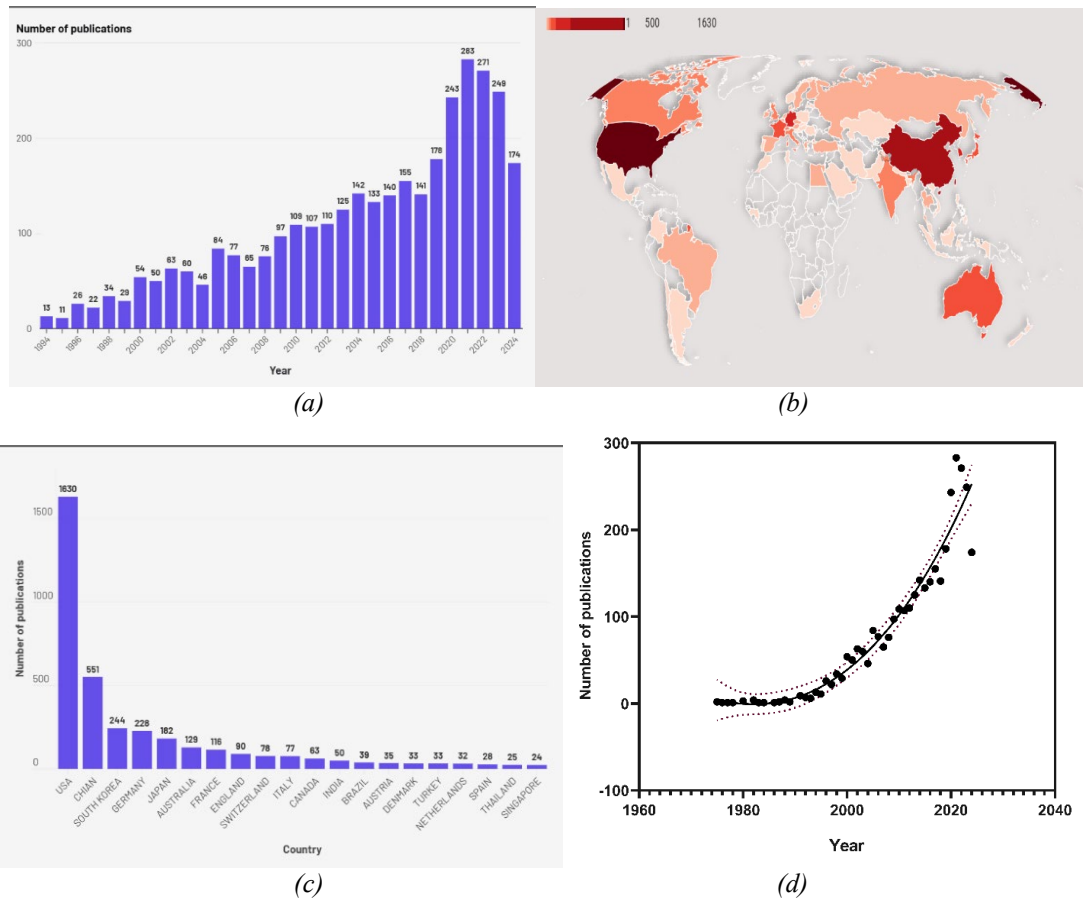
volume. From 1900 to 2023, a notable trend can be observed is the continuous increase in the number of global publications each year. In addition, in the past few years, the relative research interest in this field has shown an upward trend(Figure 1a).

**3.1.2 The contributions of various countries**

A total of 68 countries and regions have contributed to this field. Among these countries, the United States has published the most related articles(1,630 articles, 47.745%), followed by China (551articles, 16.139%), South Korea (244articles, 7.147%), Germany (228articles, 6.678%), and Japan (182articles, 5.331%) (Figures 1b, c).

**3.1.3 Global publishing trends**

Global publication trends use logistic regression models to create a time curve of the number of publications, from which future trends can be predicted[18].Figure (1d) shows the model fitting curve for predicting the growth trend of the number of global publications in the coming years.



(a) The number of publications in each year regarding ALIF and related research interests; (b) A world distribution map of ALIF and related research; (c) The total number of publications related to ALIF in the top 20 countries; (d) A fitting curve for predicting the growth trend of global publication numbers in the coming years

Figure 1: Global publication trends on ALIF and related research

**3.2 The quality of publications in different countries**

**3.2.1 Total citation frequency**

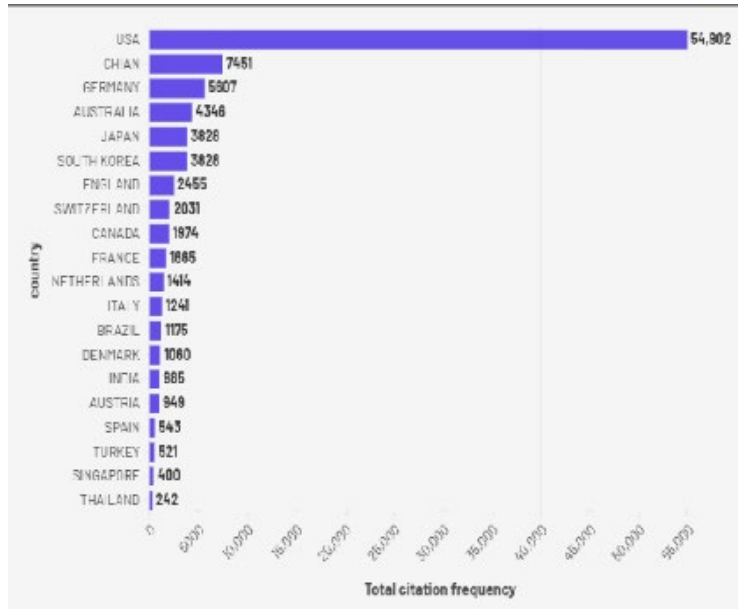
The total citation frequency of publications from different countries: The total citation frequency of publications from the United States is the highest (54,902). China ranks second in total citation frequency (7,451), followed by Germany (5,607), Australia (4,346), and South Korea (3,828) (Figure 2a).

**3.2.2 Average citation frequency**

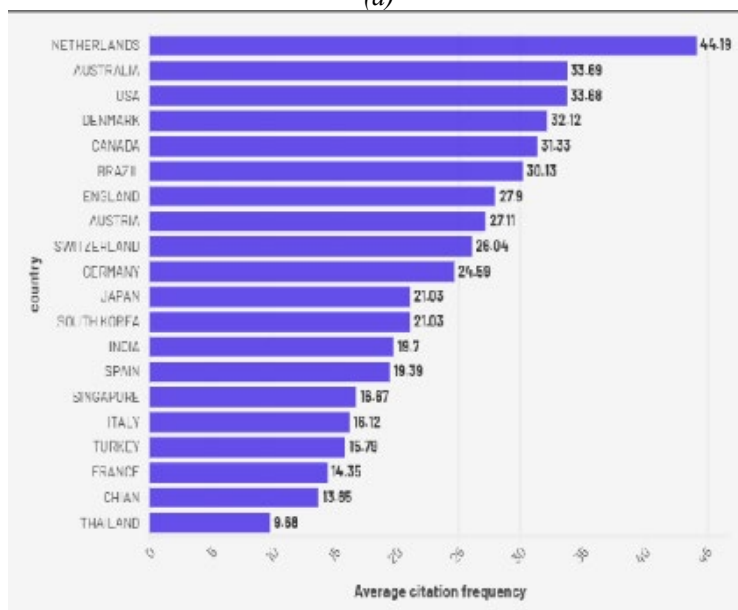
The average citation frequency of Dutch publications is the highest (44.19). Australia ranks second in average citation frequency (33.69), followed by the United States (33.68), Denmark (32.12), and Canada (31.33) (Figure 2b).

**3.2.3 h-index**

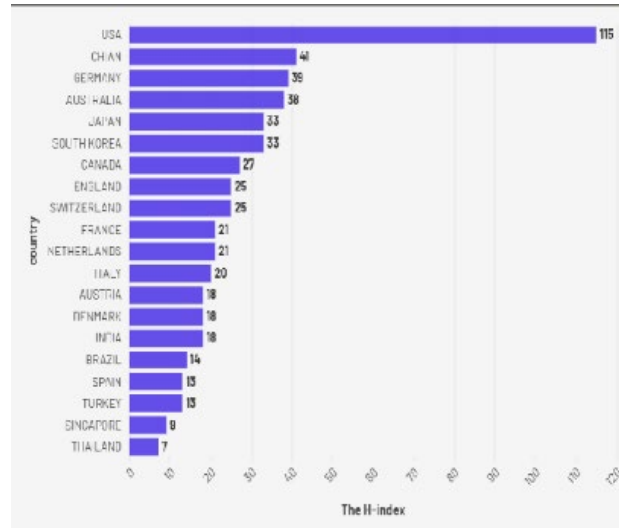
The country with the highest h-index is the United States (115), followed by China (41), Germany (39), Australia (38) and South Korea (33) (Figure 2c).



(a)



(b)



(c)

(a) Total citation frequency of National publications on ALIF and related research (b) Average citation Frequency of national publications on ALIF and related Research (c) h-index of National Publications on ALIF and Related Research

Figure 2: *Quality of Publications from Different countries*

### 3.3 Evaluation of global publications

#### 3.3.1 Journal Analysis

The top-ranked journal for ALIF research is Spine (with an impact factor [IF]=3.2), which has published 459 articles. There are 271 articles in the European spine journal (IF=3.1) and 224 articles in the Journal of neurosurgery-spine (IF=3.4). There are 216 articles (IF=2) related to ALIF studies in World neurosurgery. The top 20 journals with the most published research are shown in Figure 3a.

#### 3.3.2 Source of funds

(Figure 3b) describes the top 20 sources of funds. The National Natural Science Foundation of China supported 91 research projects (ranked first), while Medtronic Corporation of the United States followed closely with 53 research projects (ranked second).

#### 3.3.3 Author

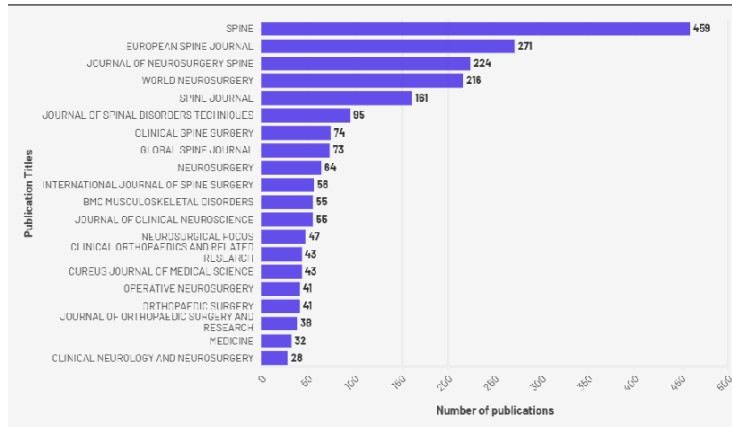
The top 20 authors published a total of 614 articles, accounting for 17.984% of all publications in this field (Figure 3c). Uribe and Juan S published 57 articles on ALIF, Vaccaro and Alexander R published 49, followed by Mummaneni, Praveen V and Singh and Kern, who published 45 and 41 articles on ALIF respectively.

#### 3.3.4 Publication agency

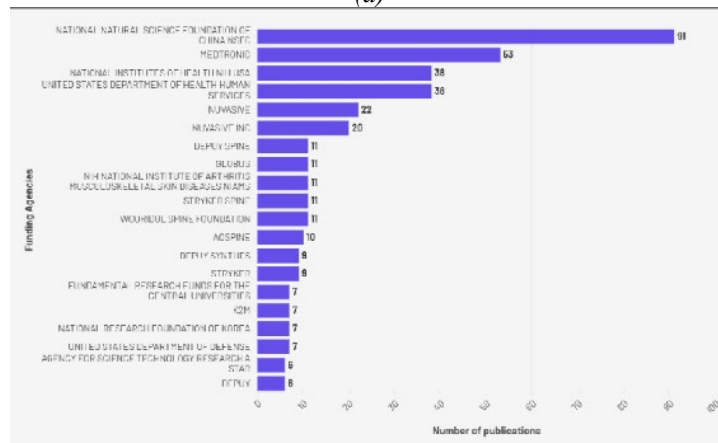
The top 20 research institutions published a total of 3,115 articles, accounting for 91.242% of all articles in this field (Figure 3D). Lippincott Williams & Wilkins (LWW), as the world's largest professional medical publisher, has published 845 related articles, ranking first. Then Elsevier published 699 articles.

#### 3.3.5 Research direction

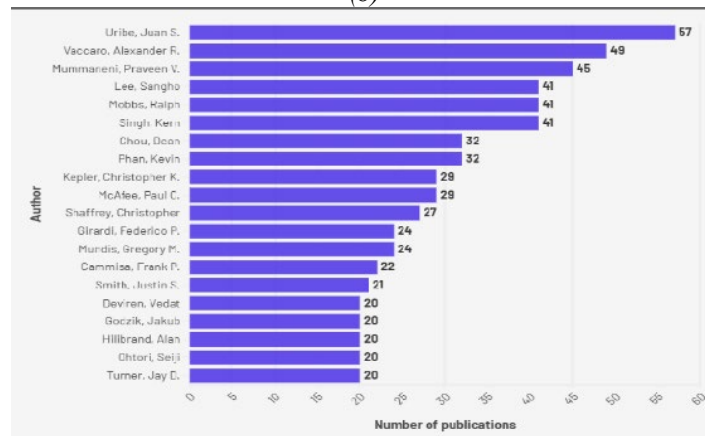
The distribution of research directions related to ALIF is shown in Figure 3e. Neuroscience, orthopedics, surgery, general internal medicine and research and experimental medicine are the most popular research fields.



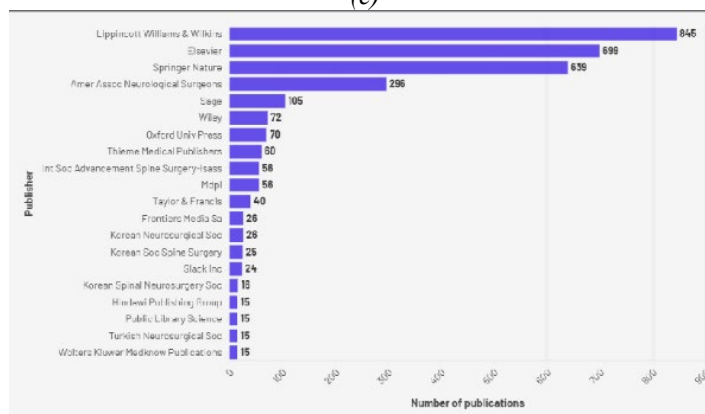
(a)



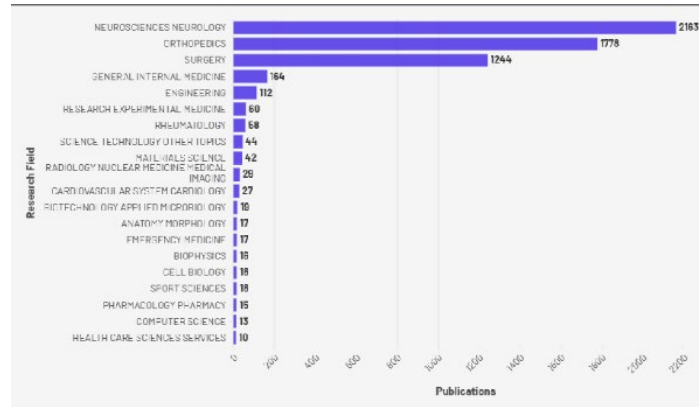
(b)



(c)



(d)



(e)

(a) The number of articles published by the top 20 journals on ALIF-related research; (b) The number of articles published by the top 20 funding agencies on ALIF-related research; (c) The number of articles published by the top 20 authors on ALIF-related research; (d) The number of articles published by the top 20 publishing institutions on ALIF-related research; (e) The top 20 research fields on ALIF The number of related research articles published

Figure 3: Evaluation of ALIF's global publications

### 3.4 Bibliographic coupling analysis

#### 3.4.1 Journal

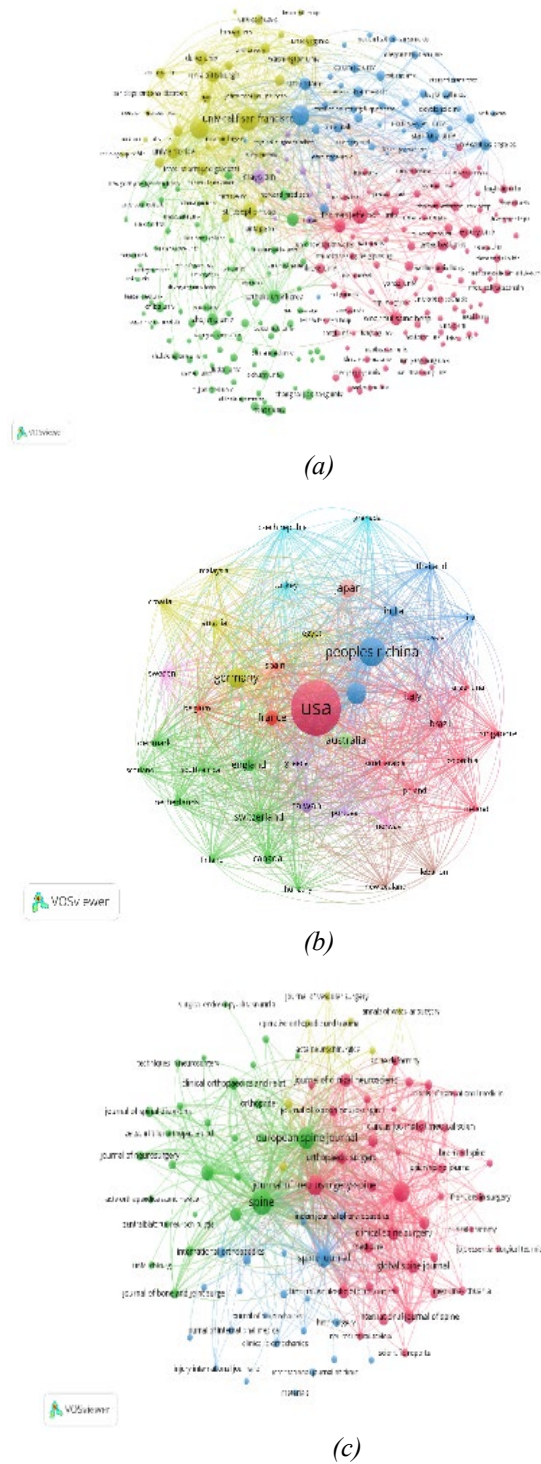
Use VOSviewer to analyze the journal names in all articles (defined as the minimum number of articles used by the journal more than five times) (Figure 4a). There are 95 identified journals in the total link strength. The top five journals in terms of total link strength are as follows: Spine (Total link strength = 196,103 times), European spine journal (total link strength = 156,659 times), Journal of neurosurgery-spine (total link strength = 130,527 times) Spine journal (total link strength = 110,140 times) and Journal of spinal disorders & techniques (total link strength = 83,927 times)

#### 3.4.2 Country

VOSviewer was used to analyze articles from 44 countries (defined as the minimum number of articles used more than 5 times in a country) (Figure 4b). The top 5 countries in terms of total link strength are as follows: the United States (total link strength = 686,029 times), China (total link strength = 242,389 times), South Korea (total link strength = 80,372 times), Germany (total link strength = 155,285 times), and Australia (total link strength = 124,615 times).

#### 3.4.3 Institution

The VOSviewer was used to analyze the institutional articles identified among 292 institutions (defined as the minimum number of articles used by the institution more than five times) (Figure 4c). The top 5 institutions in terms of total link strength are as follows: University of San Francisco, USA (total link strength = 100,143 times), Rash University, USA (total link strength = 101,257 times), New York Hospital for Special Surgery, USA (total link strength = 74,456 times), University of Florida, USA (total link strength = 92,717 times), Chiba University, USA (total link strength = 52,742 times), and Prince of Wales Hospital, Chinese Hong Kong The hospital (total link strength = 52,481 times).



(a) Network map of 95 journals related to ALIF research (b) Network map of 44 countries related to ALIF research (c) Network map of 292 institutions related to ALIF research

Figure 4: Bibliographic coupling analysis of ALIF studies

### 3.5 Co-author analysis

#### 3.5.1 Author

Co-author analysis indicates that the relevance of a project depends on the number of its co-authored papers. VOSviewer was used to analyze 389 authors (defined as the minimum number of articles used by an author more than 5 times) (Figure 5a). The top five authors in terms of total link

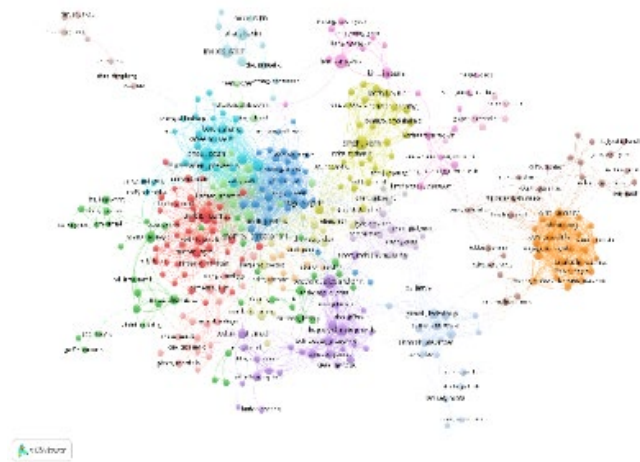
strength are as follows: Uribe, Juan s. (Total link strength =261 times), Chou, Dean (total link strength =233 times), Ohtori, Seiji (total link strength =210 times), Orita, Sumihisa (total link strength =206 times), and Aoki Yasuchika (total link strength =191 times).

### 3.5.2 Institution

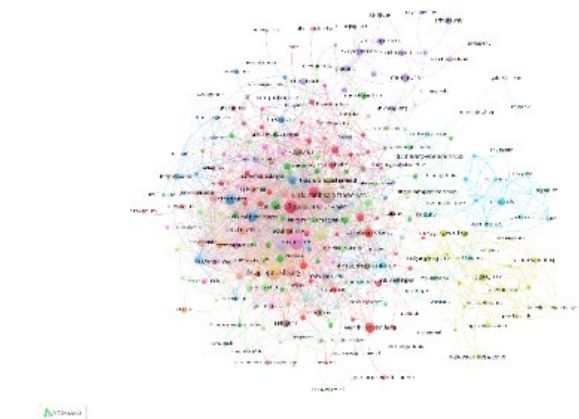
VOSviewer analyzed the studies of 278 institutions (defined as the minimum number of articles used by an institution more than five times) (Figure 5b). The top five institutions in terms of total link strength are as follows: University of San Francisco, USA (total link strength =253 times), New York Hospital for Special Surgery, USA (total link strength =179 times), University of Pittsburgh (total link strength =169 times), Duke University (total link strength =155 times), and University of Kansas (total link strength =125 times).

### 3.5.3 Country

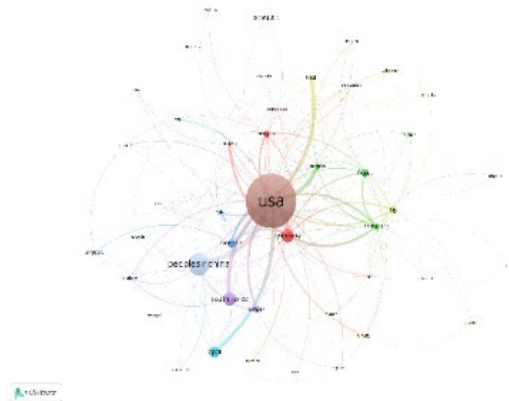
Publications from 44 countries (defined as the minimum number of articles used more than five times in a country) were analyzed using VOSviewer (Figure 5c). The top five countries in terms of total link strength are as follows: the United States (total link strength =336 times), Germany (total link strength =107 times), China (total link strength =89 times), Switzerland (total link strength =75 times), and Canada (total link strength =58 times).



(a)



(b)



(c)

(a) Analysis chart of 389 co-authors of the ALIF study (b) Plotting of the ALIF collaboration analysis among 278 institutions (c) Plotting of the ALIF study involving 44 countries

Figure 5: Co-authored analysis of ALIF studies

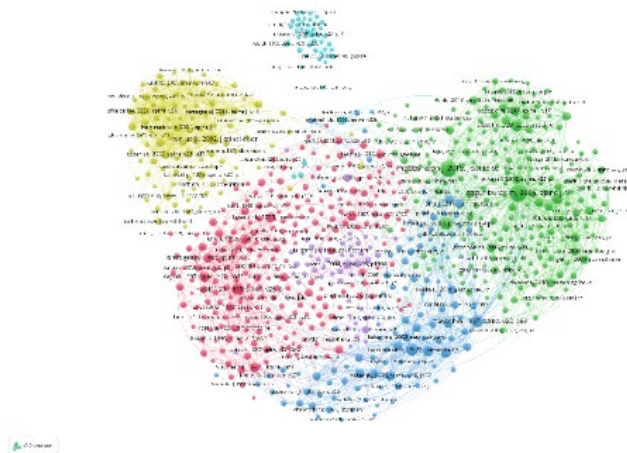
### 3.6 Co-citation analysis

#### 3.6.1 Article

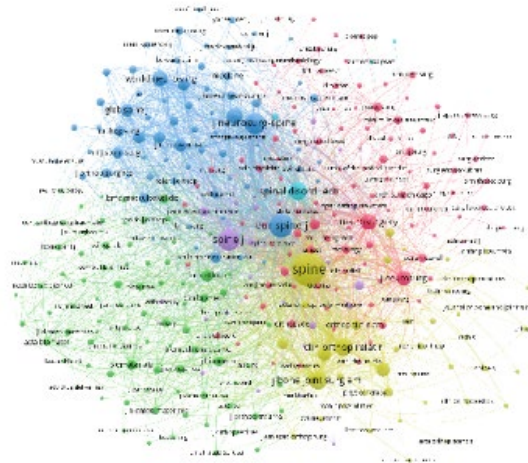
According to co-citation analysis, the correlation between things depends on the number of times they are co-referenced. VOSviewer was used to analyze 792 articles (defined as the minimum number of articles with references used more than 20 times) (Figure 6a). Here are the first five studies with high total link intensity: ozgur burak m, 2006, spine j, v6, p435, doi: 10.1016 / j.s. Pinee 2005.08.012; mobbs ralph j, 2015, j spine surg, v1, p2, doi 10978 /j.issn.2414-469x.2015.10.05; kuslich sd, 1998, spine, v23, p1267, doi 10.1097/00007632-199806010-00019; burkus jk, 2002, j spinal disord tech, v15, p337, doi 10.1097/00024720-200210000-00001 and rajaraman v, 1999, j neurosurg V91, p60, doi: 10.3171 / spi. 1999.91.1.0060.

#### 3.6.2 Journal

Use VOSviewer to co-cite and analyze the names of journals (defined as the minimum citation count of co-citations exceeding 20 times). As shown in (6b), 329 identified journals appeared in the total link strength. The top 5 journals in terms of total link strength are as follows: Spine (Total link strength = 793,512 times), Eur Spine journal (Total link power = 295,678 times), Spine journal (ratio to total link strength = 222,374 times) Journal neurosurg-spine (total link strength = 195,879 times) and Journal bone joint surg am (total link strength = 148,944 times).



(a)



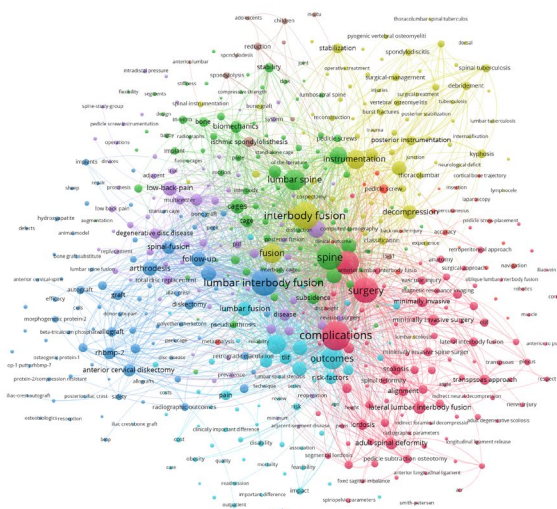
(b)

(a) A network diagram of common references cited in this field (b) A network diagram of the journals commonly cited in this field

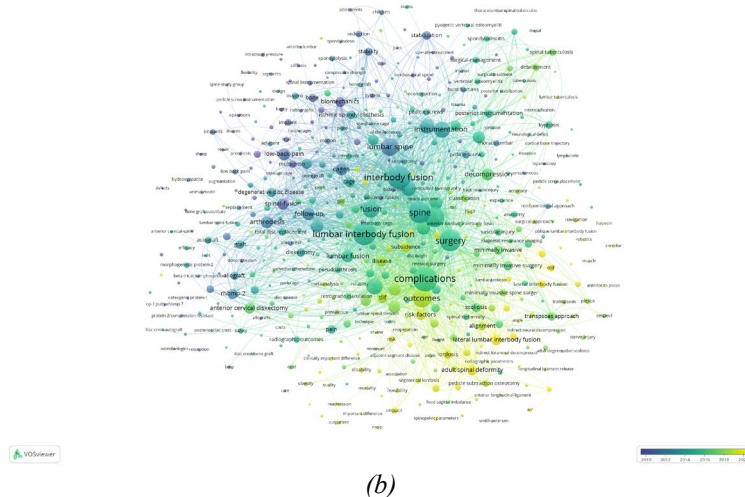
Figure 6: Co-citation network diagram of ALIF

### 3.7 Co-occurrence analysis

The purpose of co-occurrence analysis is to identify research directions and hot topics (defined as the minimum number of keyword uses exceeding 10 times), and it is even very important for the development of scientific research directions. As shown in (Figure 7a), 517 identified keywords are classified into five clusters, roughly: "Spine", "Surgery", "lumbar fusion", "vertebral body fusion" and "Outcome" (Figure 7a). In the "surgery" cluster, the commonly used keywords are: anterior approach, complications, minimally invasive, adult spinal deformities and improvement methods. For the "spine" cluster, the main keywords are: lumbar vertebrae, fixation, posterior approach, and fusion device. For the "lumbar fusion" cluster, the main keywords are: follow-up, spinal fusion, joints, and rhBMP2. For the "vertebral fusion" cluster, the main keywords are: fusion, instruments, decompression, and management. Finally, for the "outcome" cluster, the main keywords are: tlf, pain, exposure, and risk factors.



(a)



(a) The keyword network diagram in the ALIF study (b) The average occurrence frequency distribution network diagram of key words

Figure 7: Co-occurrence analysis of ALIF studies

These results indicate that the most prominent areas in the research of anterior lumbar intervertebral fusion include the above five directions. VOSviewer color-codes the keywords based on the average time they appear in all included publications (Figure 7b). Blue indicates that the keyword appears earlier, while yellow indicates that the keyword appears later. Before 2016, that is, in the early stage of research, most studies focused on "lumbar fusion", "spine" and "surgery". The latest trends indicate that the fifth cluster, namely "results", will receive widespread attention in the future.

#### 4. Discuss

##### 4.1 Global publishing status and quality

The research trends of ALIF references and visual analysis can show the current progress in the scientific research field and make predictions<sup>[19]</sup>. Therefore, this study aims to evaluate the contributing countries, institutions, funding agencies and research priorities of ALIF research<sup>[20]</sup>.

Research related to ALIF has always remained at a popular level<sup>[21]</sup>. As shown in this study, the number of publications published each year has increased significantly. In addition, in the past few years, research interest in ALIF has increased sharply. A total of 60 countries have published relevant research in this field. Based on the current data, we predict the number of future publications. More in-depth studies on ALIF will be published in the coming years. The current results, in turn, will enable researchers to conduct further high-quality studies.

According to the analysis results of national contributions, it can be seen that China ranks second in terms of the overall number of publications. However, in reality, China's academic scoring system tends to focus on quantity rather than quality. This can explain why the differentiation in the quantity and quality of publications leads researchers and doctors to be eager to submit articles while neglecting research quality. China's gradually expanding research funding will significantly enhance the quality of publications to keep pace with the global quality of publications in this field<sup>[22]</sup>.

##### 4.2 Research significance

From the perspective of promoting the development of the discipline, this study identified five hot topics in ALIF research through co-occurrence analysis: "Spine", "Surgery", "lumbar fusion", and "Outcomes". These hot topics not only reflect the main directions of current research, but also reveal possible research directions in the future<sup>[23]</sup>. For instance, keywords such as intervertebral fusion, influencing factors, fixation, and decompression occupy significant positions in the co-occurrence network diagram, indicating that research in these fields has a remarkable promoting effect on the development of the discipline.

From the perspective of its application value in solving practical problems, ALIF, as a surgical technique widely used in the treatment of degenerative lumbar spondylosis, its clinical efficacy and prognosis are the focus of research<sup>[24]</sup>. Studies have shown that the clinical efficacy after ALIF surgery is a rapidly developing research field, and more related studies will be published in the coming years. These studies not only help improve surgical techniques and treatment outcomes, but also provide scientific basis for clinical decision-making, thereby better solving practical problems.

In terms of the distribution of research forces, the United States holds a dominant position in ALIF research, publishing the largest number of papers, with the highest total citation frequency and H-index. This indicates that the United States has a relatively high academic level and considerable influence in this field. China ranks second in the overall number of publications, but still lags behind the United States in terms of citation frequency and H-index. The distribution of this research force has a significant impact on academic exchanges, scientific research cooperation and knowledge dissemination. Research institutions and scholars in the United States have strong international cooperation capabilities and influence, which can drive the improvement of global research levels<sup>[25]</sup>.

From the perspective of the disciplinary development and future potential of the literature growth trend, bibliometric analysis shows that the number of global research and publications on ALIF is increasing every year, especially during the period from 2010 to 2024, with a significant increase in research interest. This growth trend reflects the research enthusiasm and development trend in the ALIF field<sup>[26]</sup>. In the coming years, with the advancement of technology and the deepening of research, it is expected that more high-quality papers will be published, further promoting the development of the discipline.

#### **4.3 Advantages and Limitations**

Although this study evaluated the current research status and trends of ALIF through visual analysis, the following limitations of this paper must be mentioned. English language research is based on the Web of Science-Science Citation Index Expanded data source. Non-english literature may be omitted, leading to language bias. Furthermore, there may be differences between the real world and the current results. For instance, some recently published high-quality papers may not be highlighted shortly after their publication due to their low citation frequency. Therefore, we still need to pay attention to the latest primary research and other non-English research in our daily research work.

### **5. Conclusion**

#### **5.1 Alif Research trends**

According to the analysis results of national contributions, the United States has the largest number of publications. Uribe, Juan S contributed the most. The National Science Foundation of the United States and Medtronic Corporation of the United States ranked first and second respectively in terms of the number of papers supported by funds for publication. The United States has made the most significant contribution to ALIF's research on the total number of published papers. In terms of total citation frequency and H-index, the United States may be regarded as a pioneer and leader in this topic. China ranks second in the overall number of publications. On the other hand, the United States ranks first in overall citation frequency and first in the H-index.

When there is a citation from a third book in the references of two books, this is called bibliographic coupling. We used bibliographies to establish similarity links and coupling analyses among different articles in this work from three perspectives: journals, institutions, and countries. The core journal research of ALIF is Spine, European spine Journal, and Journal of neurosurgery-spine. Spine journal and Journal of spinal disorders & techniques. And the above-mentioned journals are more likely to report the latest research progress in this field. Meanwhile, Spine and European spine journal are the journals with the largest number of papers, indicating that this journal is at the forefront of international ALIF research. The University of San Francisco (with a total link strength of 253 times) has the highest total link strength and is regarded as a leading institution in ALIF research. The top three institutions in the world that publish the most articles all come from the United States, which is consistent with the leading position of the United States in this field. Almost all of the top 20 institutions come from the top five countries. Therefore, it can be seen that the establishment of first-class research institutions plays an indispensable role in enhancing a country's academic level. As shown in (Figure 3C), Uribe, Juan S, Vaccaro, and Alexander R are the most important contributors

among them. We should closely monitor the latest progress of their further research and newly published articles in the ALIF study. The co-publication of papers is of great significance for promoting scientific development: research innovation, knowledge sharing and improving the quality of scientific research. The co-author analysis method assesses the collaboration among different countries, institutions and authors. Authors, institutions and countries with higher overall link strength are more willing to cooperate. For example, Uribe, Juan S, the University of San Francisco and the United States are the best choices for our joint efforts. The purpose of this co-citation analysis is to determine the impact of the research based on the number of times it is cited. Current research findings indicate that ALIF's signature research has a high overall citation frequency and provides many meaningful references. It is well known that Spine and Journal of neurosurgery-spine is the most widely mentioned in this topic.

### 5.2 The research focus of ALIF

We used co-occurrence analysis to identify the research directions and hot issues in this field. Create a co-occurrence network graph using all the terms in the research title and abstract. Figure 7a shows five research directions, including "Spine", "Surgery", "Lumbar fusion", and "Outcomes". These studies can help clarify future research directions. Key words such as intervertebral fusion, influencing factors, fixation, and decompression are more common and play an important role in the co-occurrence network diagram<sup>[27]</sup>. Therefore, additional high-quality research was conducted on ALIF, and these three aspects of indication remain necessary. The superimposed visualization map is similar to the co-occurrence map. The colors (Figure 7b) represent the release year of the described research, but the colors of the projects are different, corresponding to the occurrence time. This method points out the exact direction for tracking research. According to the survey results, the risk factors in the results may be the next hot issue in this field. Therefore, risk factors, pain, and comparative studies with transforaminal lumbar interbody fusion TLIF may become popular directions in the research of ALIF, especially in those research directions involving ALIF in recent years, the term "risk factors" has appeared widely. Therefore, the clinical efficacy and prognosis of ALIF may be the main focus in this field<sup>[28]</sup>.

### 5.3 Summary and Prospect

This study conducted a comprehensive analysis of the global development trends in the field of ALIF research through bibliometric methods. The results show that ALIF research has received extensive attention and in-depth study worldwide. In the future, with the continuous advancement of technology and the expansion of clinical applications, the research field of ALIF will pay more attention to aspects such as surgical outcomes, prevention and treatment of complications, and the development of new fusion devices. Meanwhile, international cooperation and exchanges will further promote the development of this field.

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### References

- [1] KASLIWAL M K, GERARD C S, TAN L A, et al. *Anterior Lumbar Interbody Fusion [M/OL]//ANATOMIC APPROACH TO MINIMALLY INVASIVE SPINE SURGERY, 2ND EDITION*. Stuttgart 30: Georg Thieme Verlag, 2019: 362-369[2024-11-26]. <https://www.webofscience.com/wos/woscc/full-record/WOS:000523970300037>.
- [2] MCLAUGHLIN M R, HAID R W, RODTS G E, et al. *Open anterior lumbar interbody fusion[J/OL]*. *TECHNIQUES IN NEUROSURGERY*, 2001, 7(2): 140-151. DOI:10.1097/00127927-200106000-00007.
- [3] MOBBS R J, LOGANATHAN A, YEUNG V, et al. *Indications for Anterior Lumbar Interbody*

- Fusion*[J/OL]. *ORTHOPAEDIC SURGERY*, 2013, 5(3): 153-163. DOI:10.1111/os.12048.
- [4] TENG I, HAN J, PHAN K, et al. A meta-analysis comparing ALIF, PLIF, TLIF and LLIF[J/OL]. *JOURNAL OF CLINICAL NEUROSCIENCE*, 2017, 44: 11-17. DOI:10.1016/j.jocn.2017.06.013.
- [5] LIN G X, NAN J N, CHEN K T, et al. Bibliometric analysis and visualization of research trends on oblique lumbar interbody fusion surgery[J/OL]. *INTERNATIONAL ORTHOPAEDICS*, 2022, 46(7): 1597-1608. DOI:10.1007/s00264-022-05316-1.
- [6] Application of artificial intelligence in glioma researches: A bibliometric analysis-Web of Science Core Collection[EB/OL]. [2024-11-26]. <https://www.webofscience.com/wos/woscc/full-record/WOS:000844370900001>.
- [7] BARUTCU A, ALKAN S, BARUTCU S, et al. Global bibliometric analysis of publications on COVID-19 in newborns[J/OL]. *CUKUROVA MEDICAL JOURNAL*, 2023, 48(4): 1265-1274. DOI:10.17826/cumj.1343840.
- [8] ZHONG Y, WANG J, LIANG Z, et al. Bibliometric and Visualization Analysis of Research Hotspots and Frontiers in Endoscopic Lumbar Discectomy[J/OL]. *Journal of Pain Research*, 2024, 17: 2165-2190. DOI:10.2147/JPR.S450586.
- [9] HIGHSMITH J, DHALL S, HAID R, et al. Treatment of cervical stenotic myelopathy: a cost and outcome comparison of laminoplasty versus laminectomy and lateral mass fusion[J/OL]. *JOURNAL OF NEUROSURGERY-SPINE*, 2011, 14(5): 619-625. DOI:10.3171/2011.1.SPINE10206.
- [10] YANG K, PEI L, WEN K, et al. Investigating Research Hotspots and Publication Trends of Spinal Stenosis: A Bibliometric Analysis During 2000-2018[J/OL]. *FRONTIERS IN MEDICINE*, 2021, 8. DOI:10.3389/fmed.2021.556022.
- [11] WU J, NIU Z, LI X, et al. Understanding multi-scale spatiotemporal energy consumption data: A visual analysis approach[J/OL]. *ENERGY*, 2023, 263. DOI:10.1016/j.energy.2022.125939.
- [12] MAO X, GUO L, FU P, et al. The status and trends of coronavirus research A global bibliometric and visualized analysis[J/OL]. *MEDICINE*, 2020, 99(22). DOI:10.1097/MD.00000000000020137.
- [13] POIRRIER M, MORENO S, HUERTA-CANEP A G. Robust h-index[J/OL]. *SCIENTOMETRICS*, 2021, 126(3): 1969-1981. DOI:10.1007/s11192-020-03857-z.
- [14] CULLIFORD D, MASKELL J, JUDGE A, et al. Future projections of total hip and knee arthroplasty in the UK: results from the UK Clinical Practice Research Datalink[J/OL]. *OSTEOARTHRITIS AND CARTILAGE*, 2015, 23(4): 594-600. DOI:10.1016/j.joca.2014.12.022.
- [15] MAO X, CHEN C, WANG B, et al. A global bibliometric and visualized analysis in the status and trends of subchondral bone research[J/OL]. *MEDICINE*, 2020, 99(22). DOI:10.1097/MD.00000000000020406.
- [16] CHEN R, JIANG Y, LU L, et al. Bibliometric analysis of research trends in stem cell therapy for knee osteoarthritis over the period 2001-2021[J/OL]. *FRONTIERS IN CELL AND DEVELOPMENTAL BIOLOGY*, 2022, 10. DOI:10.3389/fcell.2022.996273.
- [17] WANG K, XING D, DONG S, et al. The global state of research in nonsurgical treatment of knee osteoarthritis: a bibliometric and visualized study[J/OL]. *BMC MUSCULOSKELETAL DISORDERS*, 2019, 20(1). DOI:10.1186/s12891-019-2804-9.
- [18] MATHUR P, KHATRI S K, SHARMA M. Prediction of Aviation Accidents using Logistic Regression Model[C/OL]//KHATRI S K, KAPUR R K, RANA A, et al. 2017 INTERNATIONAL CONFERENCE ON INFOCOM TECHNOLOGIES AND UNMANNED SYSTEMS (TRENDS AND FUTURE DIRECTIONS) (ICTUS). New York: IEEE, 2017: 725-728[2024-11-26]. <https://www.webofscience.com/wos/woscc/full-record/WOS:000428140500139>.
- [19] LE H, WICK J, VAN B, et al. Ossification of the Posterior Longitudinal Ligament: Pathophysiology, Diagnosis, and Management[J/OL]. *JOURNAL OF THE AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS*, 2022, 30(17): 820-830. DOI:10.5435/JAAOS-D-22-00049.
- [20] WU J, CHEN Y, HUANG W. Ossification of the Posterior Longitudinal Ligament in Cervical Spine: Prevalence, Management, and Prognosis[J/OL]. *NEUROSPINE*, 2018, 15(1): 33-41. DOI:10.14245/ns.1836084.042.
- [21] SASSO R C, BEST N M, MUMMANENI P V, et al. Analysis of operative complications in a series of 471 anterior lumbar interbody fusion procedures[J/OL]. *SPINE*, 2005, 30(6): 670-674. DOI:10.1097/01.brs.0000155423.18218.75.
- [22] DAVIES B, MOWFORTH O, WOOD H, et al. Improving Awareness Could Transform Outcomes in Degenerative Cervical Myelopathy [AO Spine RECODE-DCM Research Priority Number 1][J/OL]. *GLOBAL SPINE JOURNAL*, 2022, 12(1\_SUPPL): 28S-38S. DOI:10.1177/21925682211050927.
- [23] FENG Z, HUANG C, GUO Z, et al. Letter to the editor concerning "Unilateral versus bilateral pedicle screw fixation with anterior lumbar interbody fusion: a comparison of postoperative outcomes"[J/OL]. *EUROPEAN SPINE JOURNAL*, 2024, 33(11): 4404-4405. DOI:10.1007/s00586-024-08489-y.

- [24] SRIRANGARAJAN T, ESEONU K, FAKOURI B, et al. Retrospective analysis of medium-term outcomes following anterior lumbar interbody fusion surgery performed in a tertiary spinal surgical centre[J/OL]. *ANNALS OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND*, 2024, 106(6): 540-546. DOI:10.1308/rcsann.2023.0082.
- [25] CHENG Z J, HE X J. [Selection strategy and prospect of lumbar fusion surgery]. [J/OL]. *China journal of orthopaedics and traumatology*, 2024, 37(8): 746-749. DOI:10.12200/j.issn.1003-0034.20230778.
- [26] MOTEGI H, YAMAZAKI M, GOTO S, et al. Proliferating cell nuclear antigen in hypertrophied spinal ligaments - Immunohistochemical localization of proliferating cell nuclear antigen in hypertrophied posterior longitudinal ligament of the cervical spine[J/OL]. *SPINE*, 1998, 23(3): 305-310. DOI:10.1097/00007632-199802010-00004.
- [27] PHAN K, LEE N J, KOTHARI P, et al. Risk Factors for Readmissions Following Anterior Lumbar Interbody Fusion[J/OL]. *SPINE*, 2018, 43(5): 364-369. DOI:10.1097/BRS.0000000000001677.
- [28] XU X, LI X, YANG T. A systematic review and meta-analysis of the clinical efficacy of anterior lumbar interbody fusion in the treatment of orthopedic spondylolisthesis[J/OL]. *ANNALS OF PALLIATIVE MEDICINE*, 2021, 10(12): 12607-12617. DOI:10.21037/apm-21-3330.