



Review article

A bibliometric analysis of brachial plexus injury from 1980 to 2022

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ABSTRACT

Background: Brachial plexus injury is a common severe peripheral nerve injury with high disability. At present, the bibliometric analysis of brachial plexus injury is basically unknown.

Methods: This article analyzes the data retrieved to the web of science and uses the R language (version 4.2), Citespace (version 6.1.R3 Advanced), Vosviewer (Lei deng university) to make a scientific map. Specifically, we analyze the main publication countries, institutions, journals where the article is published, and the cooperative relationship between different institutions, the relationship between authors, main research directions in this field, and current research hotspots.

Results: From 1980 to 2022, the total number of publications is 1542. In terms of countries where articles were published, 551 records were published in the United States, accounting for 35% of the total. With 74 articles, Fudan University ranks first in the world in terms of the number of articles issued by the institution, followed by 72 articles from Mayo Clinic. The magazine with the largest number of articles is JOURNAL OF HAND SURGERY-AMERICAN VOLUME, which has published 87 articles in total. GU YD (Gu Yu-Dong) team (Fudan University) and spinner RJ (Robert J Spinner) team (Mayo clinic) are in a leading position in this field. Nerve transfer and nerve reconstruction have been a hot topic of brachial plexus injury. "Spinal nerve root repair and reimplantation of avulsed ventral roots into the spinal cord after brachial plexus injury" has the strongest citation bursts.

Conclusion: Research on brachial plexus injury shows a trend of increasing heat. At present, there is a lack of communication and cooperation between scholars from different countries. Nerve transfer and nerve reconstruction are the current and future research directions in the treatment of brachial plexus injury.

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1. Introduction

Brachial plexus injury (BPI) is a common severe peripheral nerve injury with a high rate of upper limb disability [1,2]. The most common cause of brachial plexus injury is traction injury of head, neck, shoulder and upper limb, which can be caused by car accident, falling from high places, crushing injury of heavy objects, fetal dystocia and so on [3]. Brachial plexus injury leads to a great number of patients suffering, resulting in a huge social and economic burden [4]. In recent years, there have been many treatments that can be used to improve the functional prognosis of patients with a brachial plexus injury [5,6]. Recently, peripheral nerve transplantation has become the first choice for treatment of brachial plexus injury [7].

However, there is still a lack of consensus on specific and effective treatment methods of brachial plexus injury in clinical practice. Understanding the characteristics of brachial plexus injury and its study history are crucial for diagnosis, treatment, and prevention. In the last century, neurophysiologists began to study the mechanisms of nerve regeneration and recovery from brachial plexus injury. They found that even in the case of severe injury, the brachial plexus still has a certain regenerative ability and can regain function with appropriate treatment and rehabilitation training [8]. Since then, researchers have made significant progress in identifying the risk factors, mechanisms of injury, and various treatment approaches for brachial plexus injury [9].

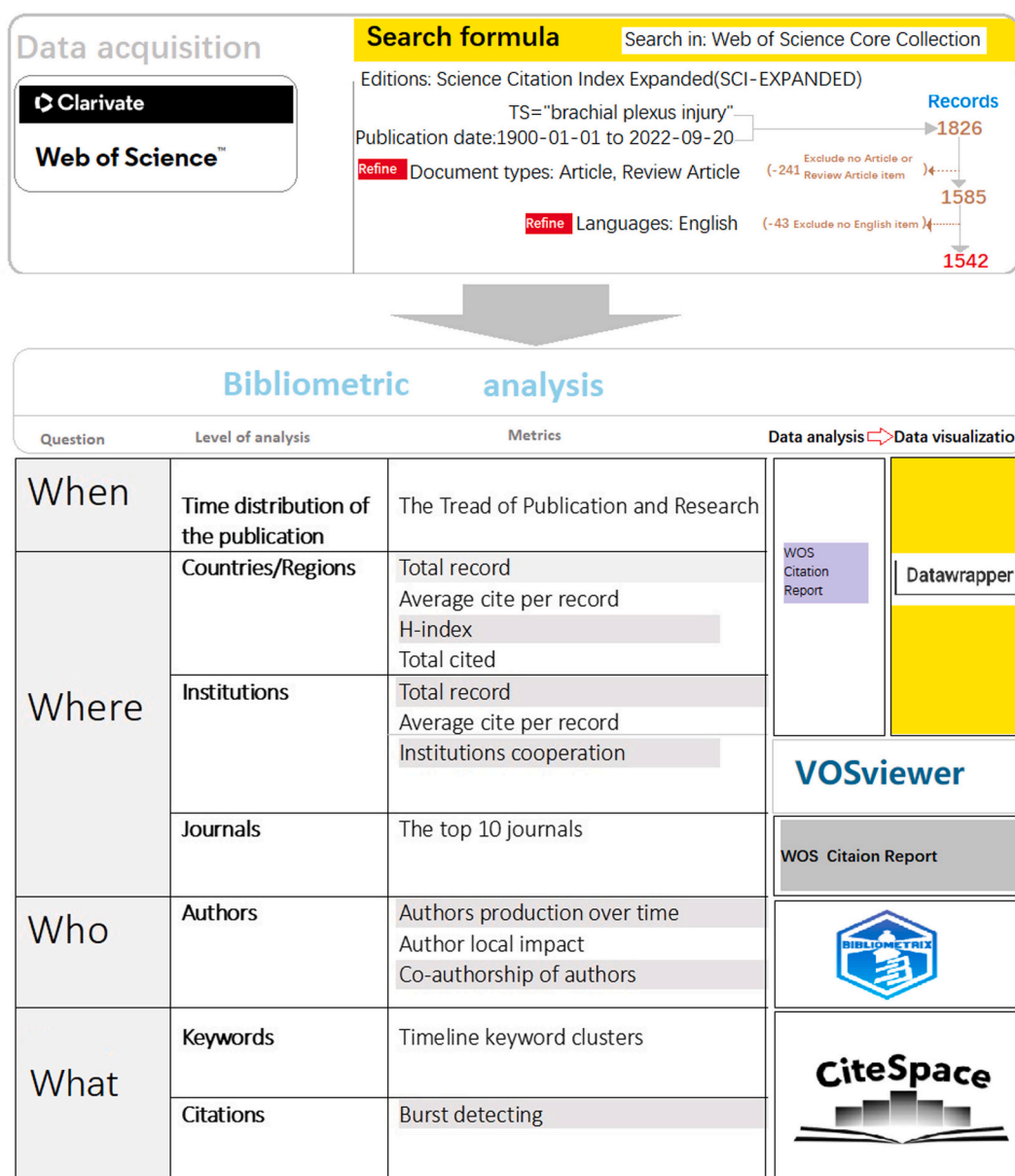


Fig. 1. Article structure chart.

Bibliometrics is often used to quantitatively analyze the literature in a specific research field to better understand the progress of this research field [10]. Currently, bibliometrics has been used in many fields including medicine [11]. In a bibliometric analysis, many research themes appear better, which helps to understand the relationships between specific research fields. At present, the bibliometric analysis of brachial plexus injury is basically unknown. The purpose of this study was to explore the research progress and trends of brachial plexus injury by analyzing the papers published by research institutions, journals and authors in different regions.

2. Methods

2.1. Data collection

We choose Science Citation Index Expanded (SCI-EXPANDED) in web of science core collection (WoSCC). The search formula is TS = "brachial plexus injury", TS stands for topic. The topic research refers to search for all topic-related parts, including the title, abstract and keywords. The time span of the literature is selected from 1980 to 2022. After obtaining the preliminary search results, we further refine it. The refinement process is to select "article" and "review" through the document type, and select "English" as the language of the article (Fig. 1). Our search time is September 20, 2022, and all data is collected within one day to prevent errors in the number of articles caused by time factors.

Select "Full Record and Cited References" in the retrieval data export, and select "Plain Text" as the data format for Vosviewer, R language and Citespace. Data retrieval and download were independently reviewed by two researchers.

2.2. Data analysis and data visualization

We obtained the results of publication time and national statistics, high-yield institutions, H factor, etc. through the citation report of Web of Science, and visualized the above data with datawrapper. H-factor is a method of evaluating academic achievement. It can be simply stated as: "There are H papers that have been cited at least H times." R software was used to make overall statistics of data, such as published authors, literature growth rate, author influence, and author's literature publication time.

Vosviewer conducts organization cooperation mapping to understand the cooperation of major research institutions.

Use Citespace to cluster brachial plexus injury and explore important documents. The parameters of CiteSpace are set as follows: The time slice is from 1980 to 2022, the year of each slice is 1, and the criteria is (g-index, $k = 25$). Through keyword clustering of documents, understand the main clusters of brachial plexus injury research at present, and analyze the time distribution of each research field through the time line atlas of clustering. We selected 5 major clusters to observe the main situation of the study. Burst is a symbol to detect the importance of literature. The beginning of a blue line depicts when an article is published. The beginning of a red segment marks the beginning of a period of burst, whereas the end of the red segment marks the end of the burst period. In this article, the duration selected was 5 years, 16 highly cited articles were detected.

Datawrapper is an easy-to-use online data visualization tool that allows users to create various types of interactive charts and maps to visually present and share data.

The literature retrieval, inclusion and exclusion, data analysis and visualization of this paper are shown in Fig. 1.

Publication record

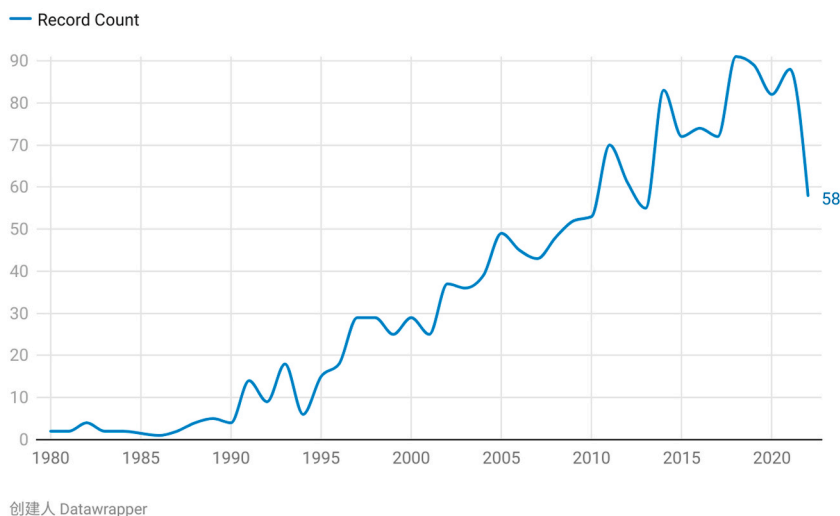


Fig. 2. Publication records.

3. Results

3.1. The tread of publication and research

From 1980 to 2022, the total number of records is 1542, including 151 reviews and 1391 original articles. See Fig. 2 for the annual number of articles. The documents were published in 475 journals, with 4949 authors and 24,426 references. The international author cooperation rate was 10.8%. There are 2493 author keywords in the article. From 1980 to 1990, the average annual number of papers issued was less than 5, and the number of papers issued was small. The number of articles published in the later period gradually increased, with an average annual growth rate of 8.48%. It reached the peak in 2018, with 91 articles. From 2018 to now, it has also maintained the number of nearly 90 articles issued each year (Fig. 2).

3.2. Countries/regions

In terms of countries where articles were published, 551 records were published in the United States, accounting for 35% of the total, followed by China (167), and England (113) (Fig. 3). The total amount of citations in the United States is significantly higher than that in other countries, but the United Kingdom ranks first in the world in terms of the H factor and the number of citations of individual articles (Fig. 4). At the same time, according to the analysis of the time chart, the American articles were mainly published in 2010, while the Chinese articles were published in 2014 (Fig. 5).

3.3. Institutions

With 74 articles, Fudan University ranks first in the world in terms of the number of articles issued by the institution, followed by 72 articles from Mayo Clinic. But as far as the reference of a single article is concerned, the Royal National Orthopaedic Hospital NHS (National Health Service) trust ranks first with 46.23, followed by the University College London 45.64, and University of London 43.7, suggesting that the quality of the above three institutions' articles is high and widely cited by the academic community (Fig. 6).

Vosviewer is used for inter-agency cooperation analysis. The size of the circle represents the number of articles, and the connection represents article cooperation. Fudan University and Ministry of Health, Shanghai Key Laboratory of Peripheral Nerve and Microsurgery, Shanghai Jiaotong University, Shanghai University Traditional Chinese Medicine have formed a strong cooperative relationship within China. Mayo Clinic's cooperative relationship is relatively scattered, but the cooperative institutions are more extensive (Fig. 7).

3.4. Journals

The top 10 journals published 398 articles, 25% of the total number of stations. The magazine with the largest number of articles is

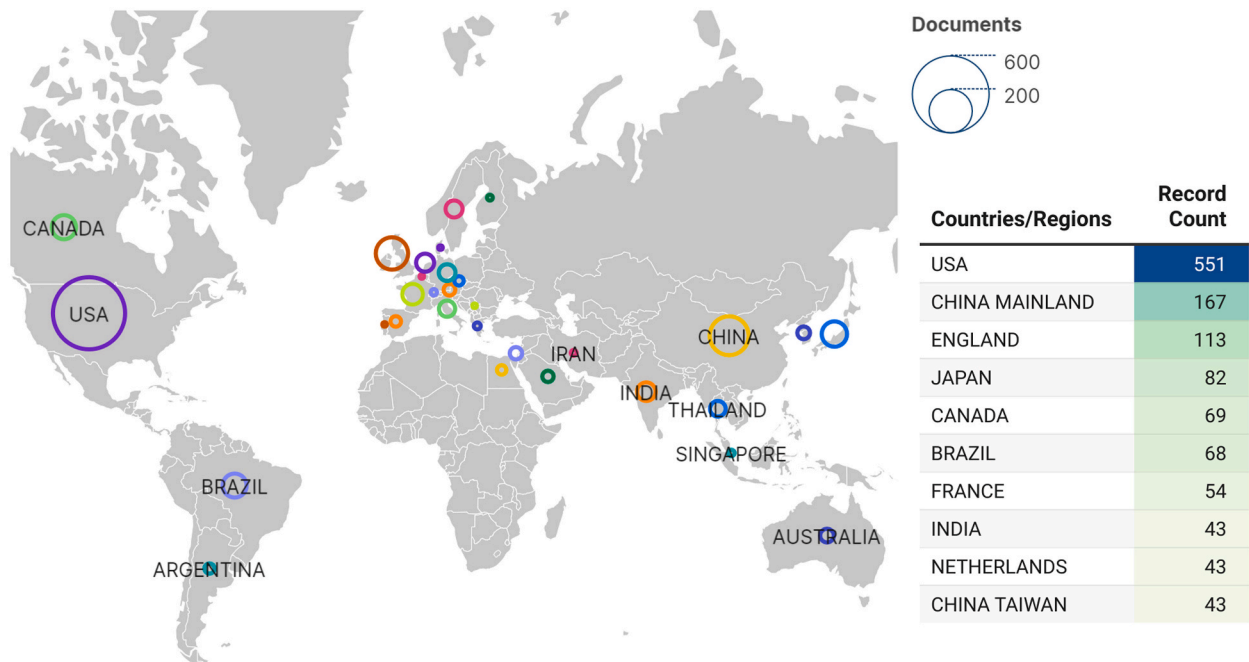


Fig. 3. Countries record total.

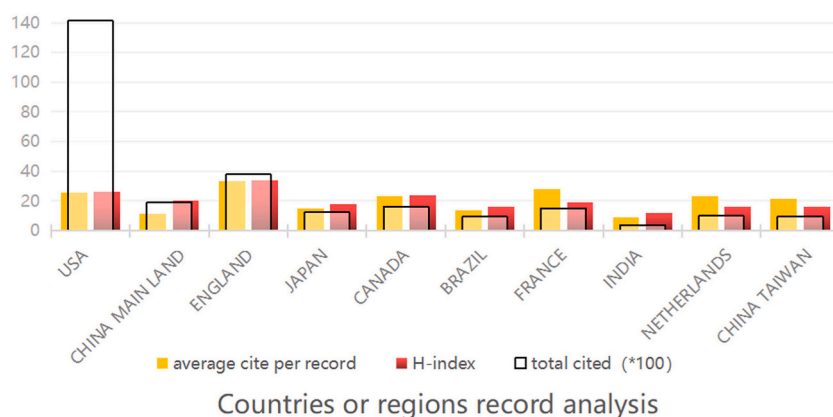


Fig. 4. Countries record analysis.

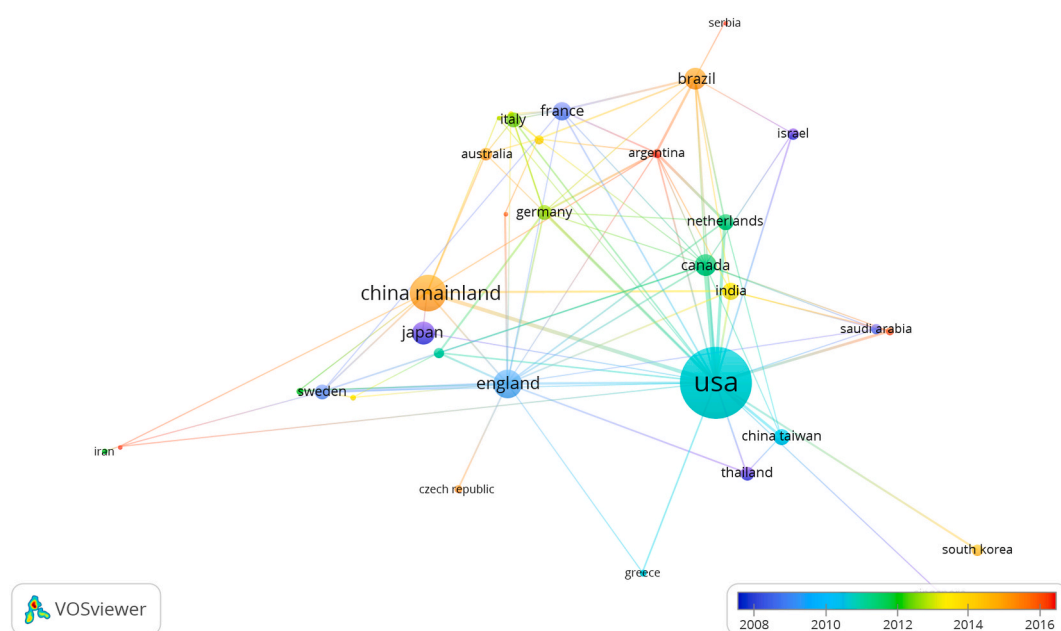


Fig. 5. Countries overlay visualization.

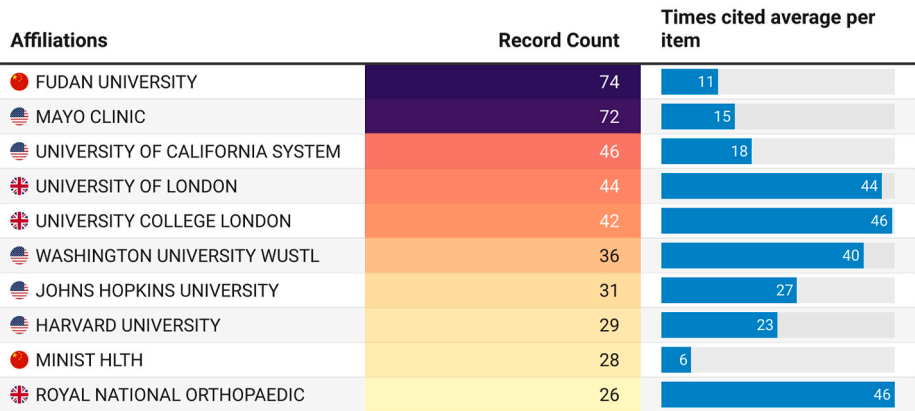
JOURNAL OF HAND SURGERY-AMERICAN VOLUME, which has published 87 articles in total. It also ranks first in the H factor and second in the average per item index, which is 39.06. In conclusion, this magazine has important influence in brachial plexus injury (Fig. 8).

3.5. Authors

We have obtained 10 authors with the largest number of articles through Web of Science. Shin AY (Alexander Y Shin) ranked first with 45 articles, followed by Spinner RJ (Robert J Spinner) 37, Bishop AT (Allen T Bishop) 35, and GU YD (Gu Yu-Dong) 31. The time when the author published the article and the author's influence were obtained through R software analysis. GU YD (Gu Yu-Dong) has been focusing on this field since 1996, and his articles are published until 2021. He is the author with the longest time span in this field (Fig. 9). According to the statistics of H factor, the influence of authors in this field can be seen that GU YD (Gu Yu-Dong) H factor reaches 16, which is the highest H factor in this field, followed by Bishop AT (Allen T Bishop), Shin AY (Alexander Y Shin), Spinner RJ (Robert J Spinner), and H factor is 14 (Fig. 10).

The author's cooperative network uses vosviewer for visualization, in which the spelling differences of some names are determined by text, and synonyms are merged. We set the number of co-authors to be 3 or more, and the number of records published by each author should be at least 5. Finally, a total of 11 author cooperation clusters with more than 3 authors were found. Cluster 1 is the largest co-authorship group, composed of 10 authors in the Department of Hand Surgery, Huashan Hospital of Fudan University. The

Affiliations records count and times cited average per item



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Fig. 6. Affiliations record count and times cited average per item.

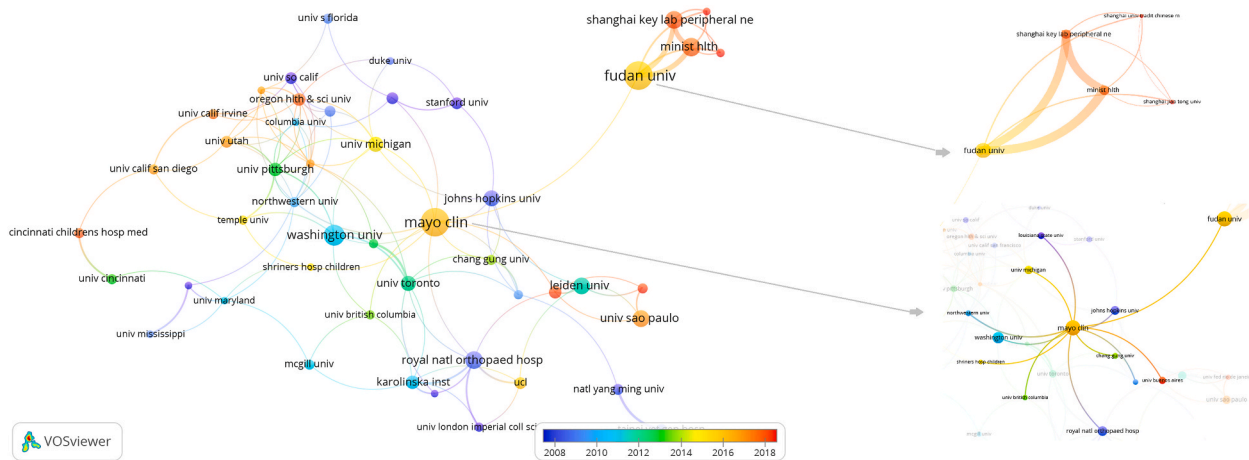


Fig. 7. Institutions cooperation chart.

central author is Gu Yu-Dong. Cluster 2 is the Mayo Clinic in the United States, with 6 authors constituting an author network. The central author is Robert J Spinner, Alexander Y Shin, and Allen T Bishop. There are 6 authors in the network of cluster 3, and they are from two institutions in Argentina and Brazil. At the same time, we noticed that the author institutions are mainly Hand Surgery, Orthopedic and Neurosurgery. Only the author institutions in Cluster 9 are Obstetrics and Gynecology (Fig. 11).

3.6. Keywords

Keywords are the core overview of a paper. Multiple keywords in an article must have some kind of connection, which can be expressed by the co-occurrence frequency [12]. It is generally believed that the more frequently words appear in a literature, the closer the connection between two keywords will be. By using Citespace, the literature clustering can conduct the keyword analysis of the time line according to the first citation time arrangement of the literature, so as to obtain the relationship between various topics in the field (Fig. 12). It is generally believed that the value of cluster modularity Q greater than 0.3 means that the cluster structure is significant. The value of cluster modularity Q in Fig. 12 is 0.8437. It is generally believed that the weighted mean silhouette S value of the cluster is greater than 0.7, which means that the cluster is convincing. The cluster weighted mean silhouette S value in Fig. 12 is 0.9428. In Fig. 12, we obtain 10 convincing and significant clusters.

We conduct an inductive analysis of the clusters in Fig. 12. #0 brachial plexus injury, #3 shoulder dystocia, #4 caesarean section, #6 brachial plexus/spinal nerve root avulsion, #7 permanent birth injury belong to clusters on the subject of causes of brachial plexus injury. #8 elbow flexion, #9 muscle spindle/contracture belong to clusters on the subject of symptoms of brachial plexus injury. #1 nerve transfer, #2 nerve reconstruction, #5 cerebral plasticity belong to the cluster with the subject of the treatment of brachial plexus injury.



Fig. 8. The top 10 journals.

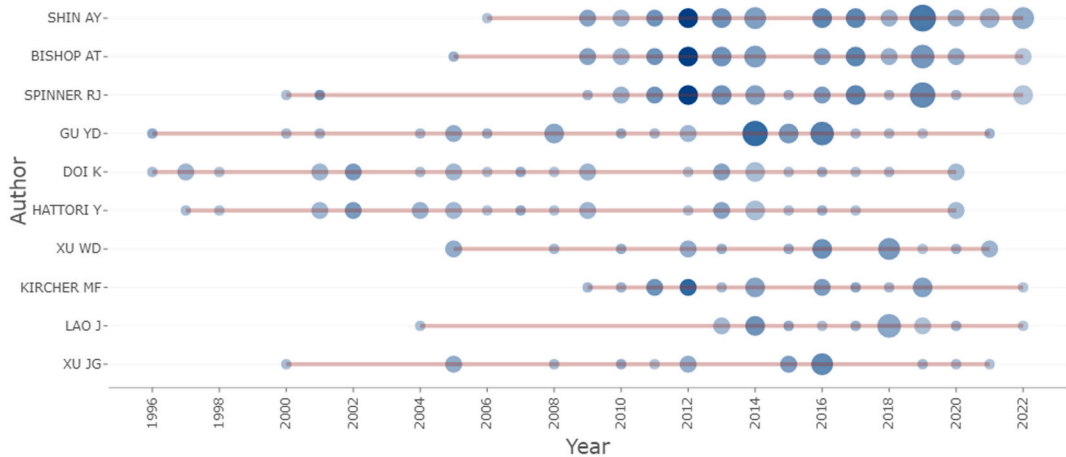


Fig. 9. Authors production over time.

According to the timeline, from 2015 to now, elbow flexion caused by brachial plexus injury is the main symptom study; Since 2010, the study of nerve transfer in the treatment of brachial plexus injury has been a hot topic; In recent years, the study of cerebral plasticity in brachial plexus injury has gradually risen.

3.7. Citations

Co-citation means that two (or more) papers are cited by one or more papers at the same time, then the two papers are said to have a co-citation relationship [12]. Burst is a symbol to detect the importance of literature [13]. The beginning of a blue line depicts when an article is published. The beginning of a red segment marks the beginning of a period of burst, whereas the end of the red segment marks the end of the burst period. In this article, the duration selected was 5 years, 16 highly cited articles were detected (Fig. 13). "Brachial plexus palsy associated with cesarean section: An in utero injury?" is the earliest highly cited paper (published in 1997) to explain the relationship between brachial plexus injury and birth injury. "Spinal nerve root repair and reimplantation of avulsed ventral roots into the spinal cord after brachial plexus injury" (published in 2000) and "Upper brachial plexus injury in adults: comparative effectiveness of different repair techniques" (published in 2015) have the strongest citation bursts, both focusing on the surgical repair treatment of brachial plexus injuries. This means that research related to surgical repair of brachial plexus injuries has continued to break out in the past 20 years, and is likely to continue to break out in the future. Specific information on highly cited literature is provided in Table 1 of the Appendix.

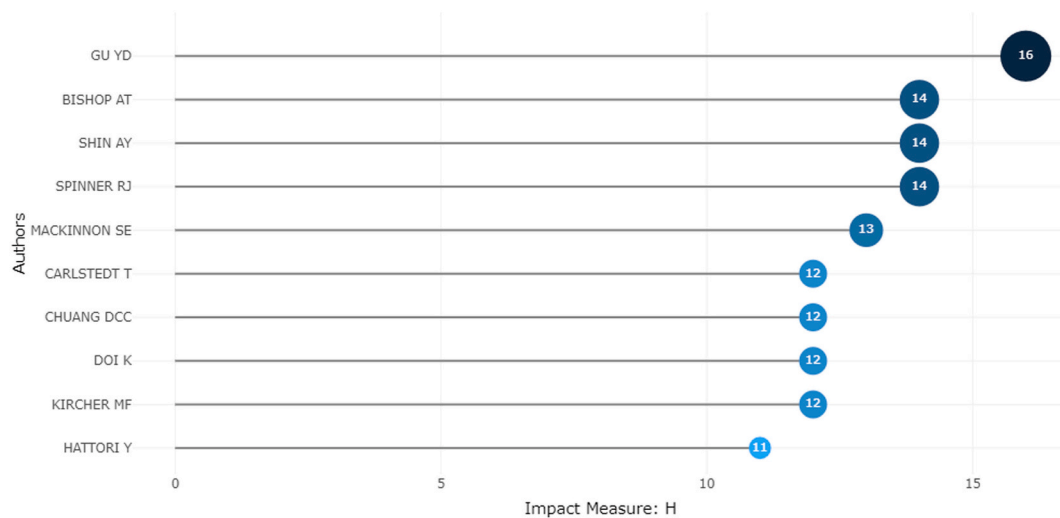


Fig. 10. Author local impact.

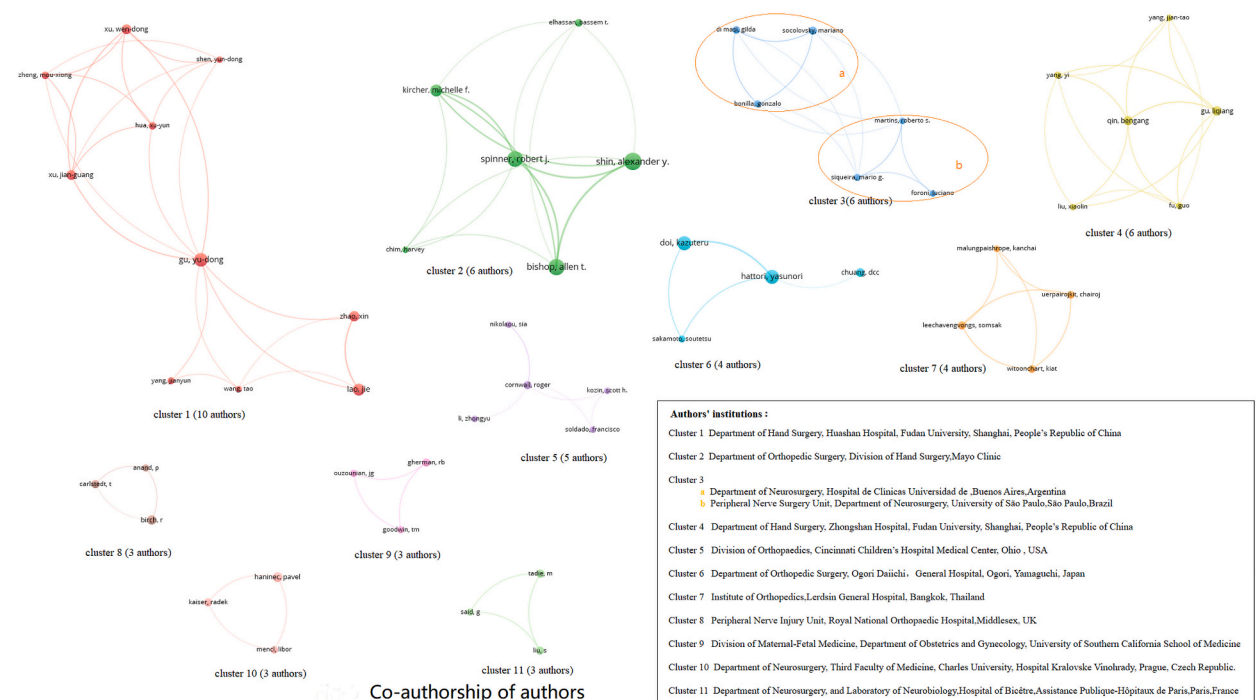


Fig. 11. Co-authorship of authors.

4. Discussion

In this study, according to the analysis results of the number of papers published in different years, we found that there was an obvious increasing trend from 1980 to 2022. From the growth curve of the number of papers and the outburst of keywords, it can be predicted that brachial plexus injury will remain a research hotspot in the future, and the literature related to the surgical treatment of brachial plexus injury will continue to increase.

In terms of the countries where the papers are produced, the USA, China and England have made great contributions in the field. The articles, journals, and institutions reflected the key role played by the USA and China in this field. According to literature analysis, GU YD (Gu Yu-Dong) team (Huashan Hospital, Fudan University) and spinner RJ (Robert J Spinner) team (Mayo clinic) are in a leading position in this field. Since the advent of the era of modern nerve transplantation began in the early 1990s, Gu Yu-Dong and his collaborators began to explore the potential of neurotization in severe plexus injuries by using extraplexus donor nerves such as the



Fig. 12. Timeline keyword clusters.

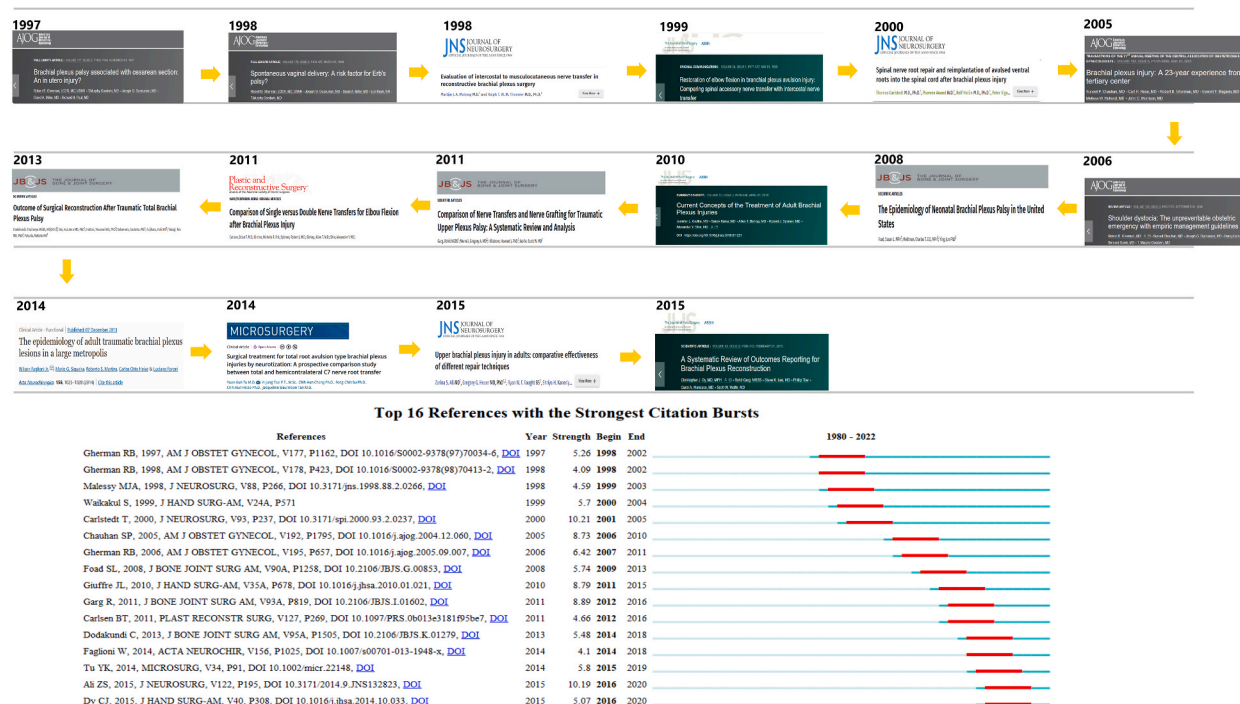


Fig. 13. Burst of 16 references.

spinal accessory nerve, the phrenic nerve, the medial pectoral nerve, the intercostal nerve and the contralateral C7 nerve [14,15]. Robert J Spinner and his collaborators focus on nerve entrapments, injuries (including brachial plexus injuries), and neuropathic pain [4,16]. Scholars from different countries are engaged in basic research and clinical treatment of brachial plexus injury, but literature analysis shows that there is a lack of communication and cooperation among them at present. Therefore, researchers from different countries and organizations should strengthen their communication and cooperation to obtain high-quality research results.

Brachial plexus injury is a damage to the neural network that controls the movement and sensation of the shoulders, arms, and hands [17]. Nerve transfer surgery has become the first choice in the treatment of brachial plexus injuries [18]. The operation of nerve transfer surgery is to transfer healthy nerves from unaffected areas of the body to injured nerves in order to restore function. For the treatment of brachial plexus injury, the main goal of all nerve transplantation operations is to restore the motor function of the upper limb [19]. The success of nerve transfer surgery depends on various factors, such as the severity and location of the injury, the timing of the surgery, and the individual's overall health. However, because healthy nerve axon regeneration requires a long distance to reach the injured nerve terminal organs, these nerve transfer procedures are not ideal [20,21]. Therefore, the recovery of upper limb function caused by brachial plexus injury will still be a hot topic in the future, and more research needs to be invested.

Nerve reconstruction is a technique used to repair brachial plexus injuries, with the aim of reconnecting damaged nerves through surgery to restore normal nerve function [2]. The concept of neural reconstruction has a broader scope than nerve transfer, including nerve grafting, nerve transfers, or nerve repair. In brachial plexus injury, nerve reconstruction typically involves reconnecting the distal end of the damaged nerve to normal nerve tissue. This can be achieved by using autologous or allogeneic nerves. Nerve grafting involves taking a healthy nerve from another part of the body, such as the legs, and using it to bridge the gap created by the damaged nerve [22]. This technique allows for the regeneration of nerve fibers and the restoration of function. Nerve repair involves directly suturing or reattaching the damaged nerve ends [6]. This technique is suitable for cases where the nerve injury is not severe and there is minimal nerve tissue loss. One of the important scientific problems in the field of nerve reconstruction is that the speed of axon regeneration is relatively slow. Georgios N Panagopoulos et al. summarized some cell components (such as Schwann cells), structural components (such as collagen), and a series of neurotrophic factors (such as vascular endothelial growth factor) in vitro that have been studied in depth, and encouraging results have been achieved [20]. Tessa Gordon et al. stated that short-term electrical stimulation of the injured proximal stump had been shown to promote nerve regeneration in several independent studies [23].

Cerebral plasticity refers to the ability of the brain to adapt to new environments or respond to new challenges by adapting and repairing its own structure and function after injury or disease [24]. In brachial plexus injury, the study of cerebral plasticity can provide important clues for us to better understand how the brain adapts and repairs brachial plexus injury [25]. Cerebral cortex is an important area that controls body movement and sensation, and its plasticity changes can affect the functional recovery of patients' upper limbs and hands. An increasing number of studies indicate that, when a brachial plexus injury occurs, the brain may undergo changes in the organization of neural pathways to compensate for the loss of function in the affected limb [26,27]. When various treatments are used for brachial plexus injury, the corresponding brain activity will also change [27]. The application research of

Table 1
16 highly cited articles.

Title	Authors	Journals	Publication Year	Study Type	Study Objective	Processing Methods	Important Conclusions
Brachial plexus palsy associated with cesarean section: An in utero injury?	Gherman RB, et al.	Am J Obstet Gynecol	1997	Case Reports	brachial plexus injury; cesarean section	a computerized search	Brachial plexus palsy can be associated with cesarean delivery
Spontaneous vaginal delivery: A risk factor for Erb's palsy?	Gherman RB, et al.	Am J Obstet Gynecol	1998	Review	Erb's palsy; shoulder dystocia	the time course of resolution and incidence of persistent injury	Erb's palsy occurring without shoulder dystocia may be a qualitatively different injury than that occurring with shoulder dystocia.
Evaluation of intercostal to musculocutaneous nerve transfer in reconstructive brachial plexus surgery	Malessy MJ, et al.	J Neurosurg	1998	Review	brachial plexus root avulsions	compared with several reported transfer techniques	Direct ICN-MC nerve transfer is a valuable reconstructive procedure.
Restoration of elbow flexion in brachial plexus avulsion injury: comparing spinal accessory nerve transfer with intercostal nerve transfer	Waikakul S, et al.	J Hand Surg Am	1999	Clinical Trial	the spinal accessory nerve transfer and the intercostal nerve transfer	a prospective randomized parallel trial	Spinal accessory nerve transfer should be used when motor function of the elbow flexors is the major concern. Intercostal nerve transfer should be performed in patients who need both motor and sensory reconstruction and in those who have chronic pain syndrome after brachial plexus injury.
Spinal nerve root repair and reimplantation of avulsed ventral roots into the spinal cord after brachial plexus injury	Carlstedt T, et al.	J Neurosurg	2000	Case Reports	injured intraspinal brachial plexus were surgically repaired	Signs of regeneration before and after surgery	Reimplantation of avulsed nerve roots may be combined with other procedures such as nerve transfers in severe cases of brachial plexus injury.
Brachial plexus injury: A 23-year experience from a tertiary center	Chauhan SP, et al.	Am J Obstet Gynecol	2005	Review	brachial plexus injury; shoulder dystocia	A review	A case of brachial plexus injury occurs 1 time in every 1000 births
Shoulder dystocia: The unpreventable obstetric emergency with empiric management guidelines	Gherman RB, et al.	Am J Obstet Gynecol	2006	Review	shoulder dystocia	Electronic databases, including PUBMED and the Cochrane Database	Despite its infrequent occurrence, all healthcare providers attending pregnancies must be prepared to handle vaginal deliveries complicated by shoulder dystocia.
The Epidemiology of Neonatal Brachial Plexus Palsy in the United States	Foad SL, et al.	J Bone Joint Surg Am	2008	Review	neonatal brachial plexus palsy	Data from the 1997, 2000, and 2003 Kids' Inpatient Database data	Neonatal brachial plexus palsy in the United States demonstrates a decreasing incidence over time. Shoulder dystocia poses the greatest risk for brachial plexus injury
Current Concepts of the Treatment of Adult Brachial Plexus Injuries	Giuffre JL, et al.	J Hand Surg Am	2010	Review	brachial plexus injuries	A review	The current concepts of the treatment of adult brachial plexus injuries and give the reader an understanding of the nuances of the timing, available treatment options, and outcomes of treatment.
Comparison of Nerve Transfers and Nerve Grafting for Traumatic Upper Plexus Palsy: A Systematic Review and Analysis	Garg R, et al.	J Bone Joint Surg Am	2011	Review	brachial plexus injury; nerve transfers	PubMed, EMBASE, and the Cochrane Central Register of Controlled Trials were searched	In patients with demonstrated complete traumatic upper brachial plexus injuries of C5–C6, the pooled international data strongly favors dual nerve transfer over traditional nerve grafting for restoration of improved shoulder and elbow function.
Comparison of Single versus Double NerveTransfers for Elbow Flexion after Brachial Plexus Injury	Carlsen BT, et al.	Plast Reconstr Surg	2011	Comparative Study	upper trunk brachial plexus injury; double nerve transfer to the biceps and brachialis nerve branches; nerve	A retrospective review	Postoperative Disabilities of the Arm, Shoulder, and Hand scores are similar in single and double nerve transfer patients.

(continued on next page)

Table 1 (continued)

Title	Authors	Journals	Publication Year	Study Type	Study Objective	Processing Methods	Important Conclusions
Outcome of Surgical Reconstruction After Traumatic Total Brachial Plexus Palsy	Dodakundi C, et al.	J Bone Joint Surg Am	2013	Clinical Trial	transfer to the biceps branch alone traumatic total brachial plexus injury; double free muscle transfer for reconstruction	Retrospective analysis	Double free muscle transfer yielded satisfactory function and allowed use of the reconstructed hand in activities that required both hands.
The epidemiology of adult traumatic brachial plexus lesions in a large metropolis	Faglioni W, et al.	Acta Neurochir	2014	Review	adult traumatic brachial plexus	Analysis of the epidemiological characteristics	In a population of adult patients with brachial plexus lesions with surgical indication, most of them comprise young male adults involved in high-energy motorcycle accidents.
Surgical treatment for total root avulsion type brachial plexus injuries by neurotization: a prospective comparison study between total and hemicontralateral C7 nerve root transfer	Tu YK, et al.	Microsurgery	2014	Randomized Controlled Trial	total root avulsion type brachial plexus injuries; C7 nerve root transfer	A prospective study	Total-CC7 transfer had better hand recovery but more donor complications than hemi-CC7.
Upper brachial plexus injury in adults: comparative effectiveness of different repair techniques	Ali ZS, et al.	J Neurosurg	2015	Meta-Analysis	Upper brachial plexus injury; different repair techniques	Both PubMed and EMBASE databases were searched	In upper trunk brachial plexus injuries in adults, the Oberlin procedure and nerve transfers are the more successful approaches to restore elbow flexion and shoulder abduction, respectively, compared with nerve grafting or combined techniques.
A Systematic Review of Outcomes Reporting for Brachial Plexus Reconstruction	Dy CJ, et al.	J Hand Surg Am	2015	Review	brachial plexus reconstruction	a systematic review	Outcome reporting for brachial plexus surgery has largely centered on motor recovery and typically has not included measures of function or nonmusculoskeletal recovery.

cerebral plasticity in brachial plexus injury can help us better understand the rehabilitation process of brachial plexus injury.

Neuropathic pain is a type of chronic pain directly caused by damage or illness to the somatosensory nervous system, which is mostly manifested as resting pain, hyperalgesia, abnormal pain and paraesthesia. Neuropathic pain can be a common complication of brachial plexus injury and can significantly impact a person's quality of life [28]. According to extensive reports, the incidence of neuropathic pain in patients with brachial plexus injuries is relatively high [29–31]. Ana Carolina Lovaglio et al. summarized neuropathic pain originating from injury to the somatosensory system and found that its chronic development depends on the destruction of the peripheral and central nervous systems. The management of these suffering requirements is complicated, so the treatment of neuropathic pain caused by brachial plexus injury requires multimodal methods such as medication, surgery, and physical therapy.

5. Conclusion

Based on the bibliometric analysis of the articles and reviews published from 1980 to 2022, we found that the USA and China were the most productive regions for the study of brachial plexus injuries. In view of the research status and cutting-edge trend of brachial plexus injuries, it is suggested that the focus be on Nerve transfer, Cerebral plasticity, Neuropathic pain, which may help scholars conduct rigorous research in the future. In addition, this study also shows the journals and institutions that published more articles and the co-authorship among organizations, authors, and countries. In the future, more cooperation from different countries and organizations are needed to promote research in this field of brachial plexus injury.

Limitation

This article has some limitations. For example, the WoSCC was the only database searched. PubMed, databases unique to other countries, such as the China National Knowledge Infrastructure, were not analyzed. However, we must remind readers that the WoSCC is the most commonly used database in bibliometric analysis.

Ethics approval and consent to participate

An ethical waiver was granted because this study did not involve human and animal subjects.

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Data availability statement

All authors have complete access to all data in the study and are responsible for the integrity and accuracy of the data. Data included in article/supplementary material. The data associated with this study is not deposited into a publicly available repository, but further data will be made available on request.

CRediT authorship contribution statement

Dong Wei: Writing – review & editing, Writing – original draft, Resources, Project administration, Investigation, Formal analysis, Data curation, Conceptualization. **Li Zhao:** Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Xu-Yun Hua:** Writing – original draft, Visualization, Supervision, Project administration, Conceptualization. **Mou-Xiong Zheng:** Visualization, Supervision, Project administration, Investigation, Conceptualization. **Jia-Jia Wu:** Visualization, Supervision, Investigation, Conceptualization. **Jian-Guang Xu:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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