Bibliometric analysis of robotic surgery research in breast cancer conducted between 2008 and 2022

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Background: To carry out a bibliometric analysis of robotic surgery research in the field of breast cancer conducted between 2008 and 2022 and to evaluate the status and trends in the field.

Methods: A systematic search was undertaken in the Web of Science (WoS) for published articles related to surgical robots and breast cancer. R and VOSviewer software were used to carry out a quantitative analysis to explore the trend of annual publication volume and the cooperative relationship between countries, institutions, authors, and keywords.

Results: A total of 177 publications were retrieved, 79.66% of which were published from 2016 to 2022, and most were conducted in the United States (US), China, and South Korea. Articles from the US had the most frequent international cooperation. A tally of institutional publications showed that Yonsei University (YONSEI UNIV; Korea) had produced the most publications. The author with the most published papers was Lee of YONSEI UNIV. The most accepted journal was the *Asian Journal of Surgery*. Keyword co-occurrence analysis showed that current research hotspots were mainly focused on nipple-conserving mastectomy and breast reconstruction, and breast-conserving and nipple-conserving mastectomy may be future research hotspots.

Conclusions: The annual incidence of robotic surgery and breast cancer is gradually increasing. The predominant countries conducting research in this field include the US, China, and South Korea, and the institutions are mainly distributed in universities and hospitals. Nipple-conserving mastectomy and breast reconstruction may be the current research hotspots, and breast-conserving mastectomy and minimally invasive surgery may represent hot research areas in the future. These findings may help scholars who are committed to the application of surgical robots to breast cancer to better understand the current research status and trends.

Keywords: Bibliometrics; research; surgical robotics; breast cancer

Introduction

Breast cancer has attracted worldwide attention due to its high morbidity and mortality, and its incidence ranks first among female cancers. The 5-year survival rate for metastatic breast cancer is less than 30%, even with adjuvant chemotherapy, targeted therapy, and endocrine therapy (1). The International Institute for Cancer Research (IARC) collected data from GLOBOCAN in 185 countries and reported that 2.3 million new breast cancer cases occurred in 2020, accounting for 11.7% of new cancers;

its mortality rate accounted for 6.9% of cancer deaths (2). At present, surgical treatment remains the most important part of breast cancer treatment strategy, and it is a common method for the treatment of breast cancer (3).

Programmable Universal Machine for Assembly (PUMA) was used by Kwoh for neurosurgical biopsy in 1985, becoming the first surgical robot used clinically in human history (4). As artificial intelligence technology matures, an increasing number of surgical robots are being approved by the United States (US) Food and Drug Administration for clinical practice (5). Some research reports have shown that surgical robots can accurately remove the breast, and have many advantages for patients such as small incisions, short operation time, and rapid postoperative recovery (6,7). However, for hospitals in underdeveloped and developing countries, high purchase and maintenance costs can limit their growth.

Bibliometrics is a research method that uses mathematics and statistics to analyze the system and metrological characteristics of literature and to explore its frequency relationship, cooperation relationship, and change law among countries, institutions, and periodicals (8). Bibliometrics has been widely used in various medical fields, such as cancer (9), respiratory medicine (10), and public health (11). At present, a variety of software is available for bibliometric analysis, such as CiteSpace (12,13) and VOSviewer (14,15), but such

software has certain defects. The R language is an emerging programming language that can comprehensively and quickly analyze data through the Bibliometricx package (16,17). To date, no bibliometric studies on breast cancer and surgical robotics have been reported.

This paper applies bibliometrics to mine and visualize the journals, authors, institutions, and countries of breast cancer and robotics-related literature from May 2008 to May 2022. We aimed to quickly sort out the relevant research hotspots and frontiers in this field, and to provide a certain reference for researchers who are committed to the application of surgical robots to breast cancer.

Methods

Literature sources

The core database of the Web of Science (WoS) was searched by the computer system, and the search time was set inception to May 15, 2022. The following information of each article was reviewed: title, journal, publication date, author information and affiliations, and keywords and abstracts.

Retrieval strategy

The search was conducted for articles including a combination of the following: "breast cancer" or "breast neoplasms" or "breast tumor" and "robotic surgery".

Exclusion criteria

Duplicate publications, publications with no publication year, and related publications that do not fit the theme.

Statistical analysis

The bibliometrics package Bibliometricx (version 3.13) in R4.1.3 software and bibliometric analysis software VOSviewer were used to analyze the original literature data. The analysis included country, institution, author, journal, literature and keyword statistics, and network visualization.

Results

Database search results

The computer system searched the core database of the WoS, and a total of 382 papers were retrieved. Some 84

Highlight box

Key findings

• We visualized the status and trends of robotic surgery application research for breast cancer, revealing that nipple-conserving mastectomy and minimally invasive surgery are current and future research hotspots.

What is known and what is new?

• Surgical resection is still the most important component of breast cancer treatment strategy. As artificial intelligence technology matures, an increasing number of surgical robots are being approved by the US Food and Drug Administration for clinical practice.

• Our study highlights the status of robotic surgery application research in breast cancer treatment and highlights the current and future research hotspots in the field.

What is the implication, and what should change now?

• This study could help researchers to quickly identify the hotspots and frontiers in the field, providing a certain reference for researchers who are committed to the application of surgical robots for breast cancer treatment.
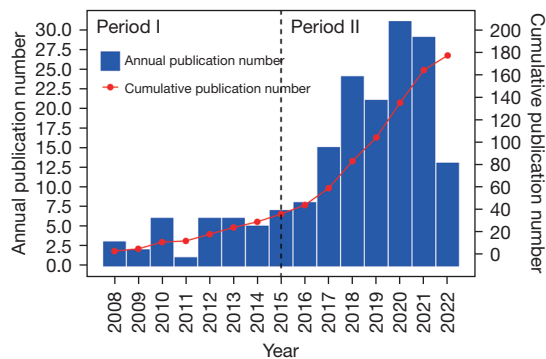

Figure 1 Graph of annual and cumulative publications from the year of 2008 to 2022 on robotic surgery research in breast cancer.

duplicate documents and 121 irrelevant documents were deleted, and 177 documents were finally obtained.

Time distribution of literature

Articles related to "breast cancer" and "robotic surgery" published from 2008 to 2022 were screened and analyzed. As can be seen from *Figure 1*, the cumulative number of published documents from 2008 to 2022 has shown a rapid growth trend, which can be divided into 2 stages according to the number of published documents: Phase I is from 2008 to 2015, and the number of publications in this period tends to be stable; Phase II is the period from 2016 to 2022. The number of articles published in Phase II showed explosive and rapid growth, and 31 articles were published in 2020 alone. A total of 36 articles were published in Phase I, and 141 articles were published in Phase II; Phase II was 3.92 times that of Phase I. From 2018 to 2022, 118 English-language articles on the application of surgical robots to breast cancer were published, accounting for 66.67% of the total number of articles. Therefore, the surgical research on the application of surgical robots to breast cancer has received mounting attention from researchers around the world since 2015.

Quantity of national publications and cooperation network relations between countries

Statistical analysis of the author's country of origin was conducted through Bibliometricx. As shown in *Figure 2*, 177 articles came from 32 countries, and 44 articles were published by American authors, accounting for 24.86% of all the total articles, ranking first; this was followed by 32

articles from China (18.08%), 29 articles from South Korea (16.38%), 18 articles from France (10.17%), 15 articles from the United Kingdom (8.47%), 12 articles from Italy (6.78%), and 12 articles from Japan (6.78%). *Figure 3* shows the relationship between the national cooperation network. In the first stage (2008 to 2015), only 17 countries including Germany, the US, and the United Kingdom participated in the publication. Among them, Germany cooperated the most with other countries, and the US published the most articles (N=27), accounting for 75% of this stage. In Phase II, the US cooperated closely with other countries, and the number of published articles reached 88, accounting for 62.41% of the total in Phase II, followed by China with 71 (50.35%); however, China engaged in relatively little international cooperation. The cooperation between countries in the second stage was higher than that in the first stage.

Quantity of institutional publications and inter-institutional cooperative network relationship

The author's publishing institutions were statistically analyzed by Bibliometrix. As shown in *Figure 4*, a total of 286 research institutions participated in its research, of which the top 3 research institutions were Yonsei University (YONSEI UNIV) in South Korea with 22 papers (12.43%), Changhua Christian Hospital in Taiwan (CHANGHUA CHRISTIAN HOSP) with 21 papers (11.86%), and European Institute Oncology with 18 papers (10.17%). The institutional cooperation relationship is shown in *Figure 5*. In the first stage (2008 to 2015), only Laval University Cancer Research Center (UNIV LAVAL CTR RECH CANC), the United States University of California, San Francisco (UNIV CALIF SAN FRANCISCO), and the United States Brown University (BROWN UNIV) cooperated more frequently. In Stage II, more institutions were researching surgical robots for breast cancer treatment, the cooperation was more frequent, and the cooperation was significantly higher than that in Stage I. Frequent cooperation was observed in 9 institutions including Johns Hopkins University, Imperial College London, and Technical University of Munich in Germany.

The number of published papers by authors and the network relationship between authors

Through Bibliometricx, the author's publication volume and the cooperation relationship between authors were
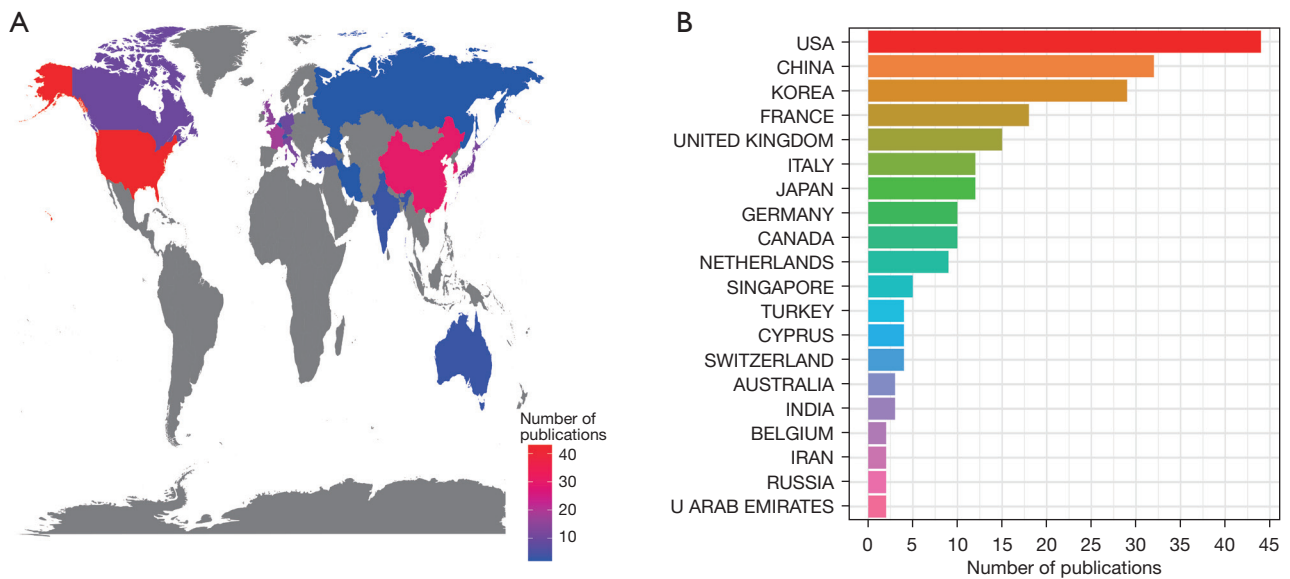
Figure 2 The number of articles relating to robotic surgery research in breast cancer with authors from different countries or regions. (A) The trend of publications in different countries or regions. (B) The ranked top 20 countries or regions from high to low.
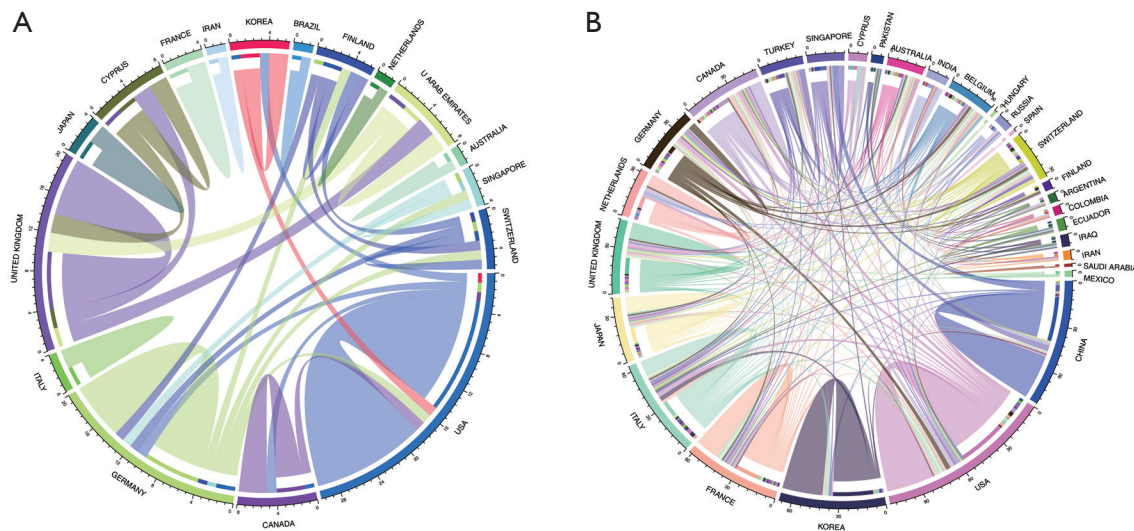

Figure 3 Network map of cooperation between different countries based on analysis relating to robotic surgery research in breast cancer. (A) The network map from 2008 to 2015. (B) The network map from 2016 to 2022.

statistically analyzed (*Figure 6*). The 177 articles contained a total of 905 authors. The top 5 authors were Lee from YONSEI UNIV School of Medicine in South Korea with 12 articles (6.78%), Lai from National Yangming University School of Medicine in Taiwan and Texas in the United States with 10 articles (5.65%). Selber of the University of Sri Lanka published an average of 10 papers

(5.65%), Chen of CHANGHUA CHRISTIAN HOSP, and Park of the Department of Surgery of YONSEI UNIV in South Korea published an average of 9 papers (5.08%), which corresponded to the number of articles published by the US, China, and Korea. The number of authors who collaborated in Phase I (2008–2015) was significantly smaller than that in Phase II (2016–2022) (*Figure 7*).
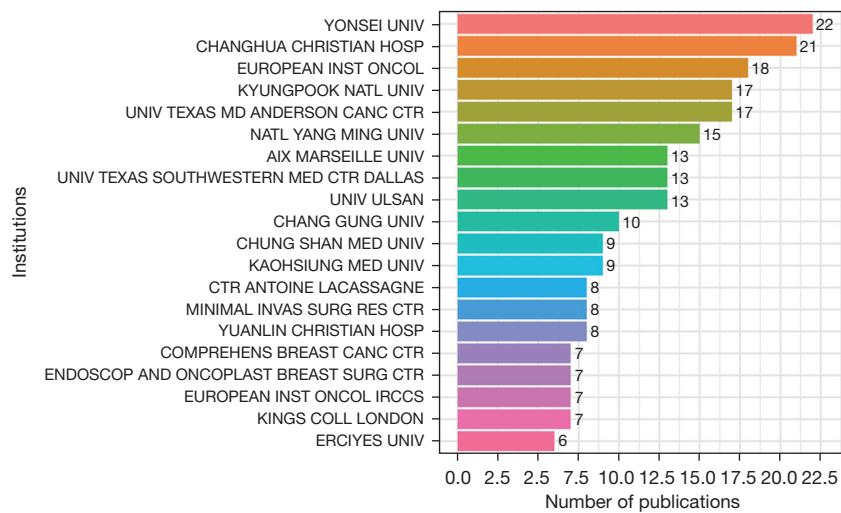
Figure 4 The top 20 institutions with published articles relating to robotic surgery research in breast cancer ranked from high to low.
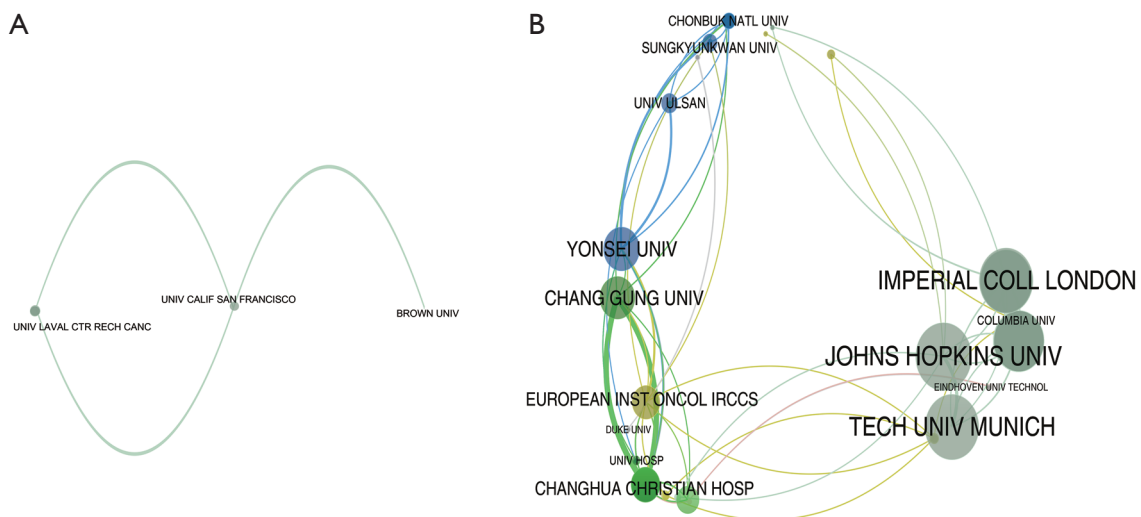

Figure 5 Network map of cooperation between different institutions based on analysis relating to robotic surgery research in breast cancer. (A) The network map from 2008 to 2015. (B) The network map from 2016 to 2022. CHONBUK NATL UNIV, Chonbuk National University; SUNGKYUNKWAN UNIV, Sungkyunkwan University; UNIV ULSAN, University of Ulsan; YONSEI UNIV, Yonsei University; CHANG GUNG UNIV, Chang Gung University; EUROPEAN INST ONCOL IRCCS, European Institute of Oncology IRCCS; DUKE UNIV, Duke University; UNIV HOSP, United Hospitals (Taiwan); CHANGHUA CHRISTIAN HOSP, Changhua Christian Hospital; IMPERIAL COLL LONDON, Imperial College London; COLUMBIA UNIV, Columbia University; JOHNS HOPKINS UNIV, Johns Hopkins University; EINDHOVEN UNIV TECHNOL, Eindhoven University of Technology; TECH UNIV MUNICH, Technical University of Munich; UNIV LAVAL CTR RECH CANC, Laval University Cancer Research Center; UNIV CALIF SAN FRANCISCO, United States University of California, San Francisco; BROWN UNIV, Brown University.
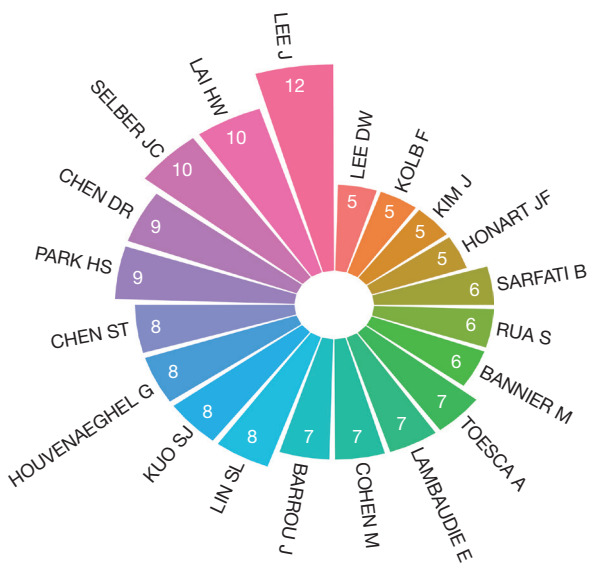
Figure 6 The top 20 authors who published articles relating to robotic surgery research in breast cancer ranked from high to low.

Cited frequency analysis

Through Bibliometricx, the total citations (TCS) and the local citations (LCS) were analyzed respectively, as shown in *Table 1* and *Table 2*. The paper with the highest TCS was "A review of tactile sensing technologies with applications in biomedical engineering", with an average annual citation count of 38.82. This paper discusses the application of tactile sensor technology in biology, indicating that it is very important for the research and development of robotics. The top LCS article was "Robotic nipple-sparing mastectomy for the treatment of breast cancer: Feasibility and safety study", a clinical evaluation study of robotic nipple-sparing mastectomy for breast cancer, suggesting that nipple-sparing mastectomy may be the current stage of research hotspots.

Journal analysis

Through Bibliometricx, a statistical analysis of the journals published on robotic surgery and breast cancer-related literature was performed, as shown in *Table 3*. The top 5 journals were the *Asian Journal of Surgery* with 35 articles, accounting for 19.77%; the *International Journal of Medical Robotics and Computer Assisted Surgery* with 9 articles, accounting for 5.08%; *Annals of Surgical Oncology* with 8 articles, accounting for 4.52%; and *Frontiers in Oncology* and *Plastic and Reconstructive Surgery* both published 6 papers,

each accounting for 3.39%. In terms of journal types, 4 journals belong to surgery, 4 journals belong to oncology, and the other 2 belong to radiation oncology, for which the impact factors are all more than 2 points.

Keywords analysis

Through Bibliometricx, the keywords of the literature related to robotic surgery and breast cancer were statistically analyzed. The top 3 keyword frequencies were breast cancer (n=180), cancer (n=151), and surgery (n=120) (*Figure 8*). VOSviewer software was used to analyze the co-occurrence of the top 50 keywords with the highest frequency. The network map was divided into 3 categories, all of which were centered on breast cancer and nipple-sparing mastectomy, including Cancer, Surgery, Nipple-sparing mastectomy, and Reconstruction (*Figure 9*).

Time distribution of keywords

The time distribution law was analyzed by KeywordGrowth in the bibliometricx package bibliometricx in the R language environment. Robotic surgery began to appear in 2008 and has continued to grow since then; breast cancer has appeared since 2010, and articles containing breast cancer have grown the most since 2016; robotic surgery is the earliest keyword, but the growth rate is small, ranked fifth (*Figure 10*).

Hotspot prediction

Through the bibliometrics package Bibliometricx in the R language environment, the "Trend topic" function under the "Documents" toolbar can visually analyze and predict the research hotspots. The time is 2008–2022, the annual research frequency was set to greater than or equal to 5 times to improve the accuracy of the results (*Figure 11*). Research hotspots have changed from the initial "breast", "tissue" and "ultrasound" to "breast-conserving surgery" and "nipple-sparing mastectomy", so the use of breast-conserving mastectomy and minimally invasive treatment of breast cancer may become the future research hotspots (18).

Discussion

In this paper, Bibliometricx package in R language and VOSviewer software were used to conduct a bibliometric analysis of related literature on breast cancer and surgical
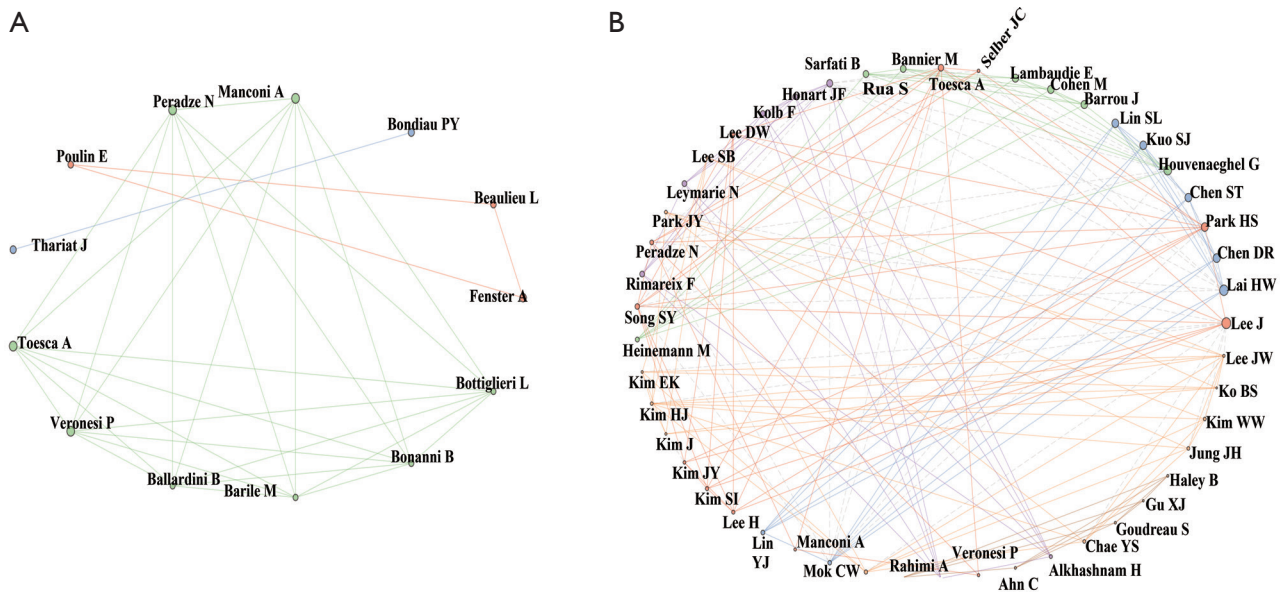
Figure 7 Network map of cooperation among researchers based on analysis relating to robotic surgery research in breast cancer. (A) The network map from 2008 to 2015. (B) The network map from 2016 to 2022.

Table 1 Top 10 articles on total citations of robotic surgery in breast cancer research

ID	Title	Total citations	Year	Journal name	Influence factor
1	A review of tactile sensing technologies with applications in biomedical	427	2012	Sens Actuators A Phys	3.407
2	Robotic latissimus dorsi muscle harvest: a case series	82	2012	Plast Reconstr Surg	4.209
3	Robotic nipple-sparing mastectomy for the treatment of breast cancer: Feasibility and safety study	70	2017	Breast	3.754
4	Rolling Indentation Probe for Tissue Abnormality Identification during Minimally Invasive Surgery	66	2011	IEEE Trans Robot	5.567
5	Intraoperative electromagnetic navigational bronchoscopic localization of small, deep, or subsolid pulmonary nodules	57	2017	J Thorac Cardiovasc Surg	4.451
6	The physical consequences of gynecologic cancer surgery and their impact on sexual, emotional, and quality of life issues	52	2013	J Sex Med	3.293
7	Cost-effectiveness analysis of intraoperative radiation therapy for early-stage breast cancer	51	2013	Ann Surg Oncol	4.061
8	Robotic Prophylactic Nipple-Sparing Mastectomy with Immediate Prosthetic Breast Reconstruction: A Prospective Study	41	2018	Ann Surg Oncol	4.061
9	Application of fluorescence in robotic general surgery: review of the literature and state of the art	40	2013	World J Surg	2.234
10	Biological research in the evolution of cancer surgery: a personal perspective	39	2008	Cancer Res	9.727

Table 2 Top 10 articles on local citations of robotic surgery in breast cancer research

ID	Title	Local citations	Year	Journal name	Influence factor
1	*Robotic nipple-sparing mastectomy for the treatment of breast cancer: Feasibility and safety study*	27	2017	*Breast*	3.754
2	*Robotic Prophylactic Nipple-Sparing Mastectomy with Immediate Prosthetic Breast Reconstruction: A Prospective Study*	19	2018	*Ann Surg Oncol*	4.061
3	*Robotic latissimus dorsi muscle harvest: a case series*	18	2012	*Plast Reconstr Surg*	4.209
4	*Robotic Nipple-Sparing Mastectomy and Immediate Breast Reconstruction with Gel Implant: Technique, Preliminary Results and Patient-Reported Cosmetic Outcome*	17	2019	*Ann Surg Oncol*	4.061
5	*The learning curve of robotic nipple sparing mastectomy for breast cancer: An analysis of consecutive 39 procedures with cumulative sum plot*	14	2019	*Eur J Surg Oncol*	3.959
6	*Update on the Feasibility and Progress on Robotic Breast Surgery*	14	2019	*Ann Surg Oncol*	4.061
7	*Robotic da Vinci Xi-assisted nipple-sparing mastectomy: First clinical report*	13	2018	*Breast J*	1.991
8	*Robotic harvest of the latissimus dorsi muscle: laboratory and clinical experience*	12	2012	*J Reconstr Microsurg*	1.841
9	*Gasless Robot-Assisted Nipple-Sparing Mastectomy: A Case Report*	12	2018	*J Breast Cancer*	2.241
10	*Robotic-assisted latissimus dorsi harvest in delayed-immediate breast reconstruction*	10	2014	*Semin Plast Surg*	1.3

Table 3 Top 10 journals with published articles in breast cancer-related fields using robotic surgery

| ID	Journal name	Number of Publications	Proportion in total issued documents, %	Country	Influence factor (2021)	CiteScore
1	*Asian Journal of Surgery*	35	19.77%	China	2.7667	3.3
2	*International Journal of Medical Robotics and Computer Assisted Surgery*	9	5.08%	England	2.522	4.30
3	*Annals of Surgical Oncology*	8	4.52%	United States	5.291	6.10
4	*Frontiers in Oncology*	6	3.39%	Switzerland	6.182	3.90
5	*Plastic and Reconstructive Surgery*	6	3.39%	United States	4.683	5.8
6	*International Journal of Computer Assisted Radiology and Surgery*	5	2.82%	Germany	2.895	5.30
7	*International Journal of Radiation Oncology · Biology · Physics*	5	2.82%	United States	6.968	9.10
8	*Journal of Breast Cancer*	5	2.82%	Korea	3.552	4.10
9	*Medical Physics*	4	2.26%	United States	4.03	6.10
10	*Cancer Research*	3	1.69%	United States	12.574	15.80
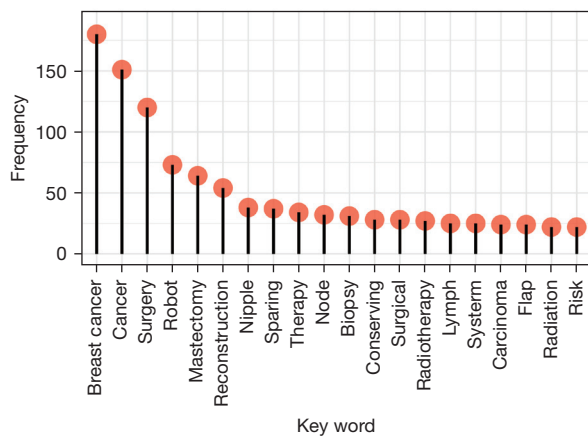
Figure 8 The top 20 keywords with the highest frequency from 2008 to 2022.

robots in the WoS Center database. By mining the annual number of published papers, the relationship between countries, institutions, and authors, the co-occurrence, distribution rules, and hotspot prediction of keywords, we expected to provide some reference for clinical and scientific researchers who are engaged in the application of surgical robots to breast cancer.

Through the statistical analysis of the time distribution of the literature by Bibliometrix, the annual publication volume in phase I (2008–2015) was found to be small, and the cumulative publication volume increased slowly. After 2015, the cumulative annual publication volume increased rapidly, which may be related to the rapid increase of the global surgical robot market from 3 billion US dollars to 8.32 billion US dollars after 2015, with a growth rate of 22.6% (19). This shows that the application of robotic surgery to the treatment of breast cancer has attracted mounting attention from clinicians and researchers, and has unlimited research prospects.

Bibliometricx was used to conduct a visual analysis of the countries, institutions, and authors of the literature, which showed that the publications of the literature were mainly concentrated in the US, China, and South Korea.

The US has consistently retained a prominent position in research on the treatment of breast cancer with surgical robots and has cooperated closely with other countries. China and South Korea started late in the research on the treatment of breast cancer with surgical robots. From 2015, although the research on the treatment of breast cancer with surgical robots has gradually increased, and the number of published papers has increased steadily, little international

cooperation has been observed. The top 3 research institutions with the most published articles are YONSEI UNIV in South Korea, CHANGHUA CHRISTIAN HOSP, and the European Institute of Oncology in Italy. The top 2 authors with the most published articles were from YONSEI UNIV in South Korea and Yangming University School of Medicine in Taiwan. This shows that the research on surgical robot treatment of breast cancer is strongly supported in China and South Korea, but the institutions and authors of the 2 countries are concentrated, and less international cooperation has occurred. The international research and development of surgical robot treatment of breast cancer in China and South Korea still need to be further improved.

Citations are an important factor in evaluating the academic impact of publications, and this study lists the top 10 papers with surgical robots applied to breast cancer TCS and LCS. The TCS top 10 literature focuses on the clinical application of nipple-sparing mastectomy, breast reconstruction, and various techniques of surgical robotics, such as tactile sensing (20), rolling indentation probe (21), fluorescence visualization (22), and other technologies. Most of the LCS top 10 literature focuses on research in the fields of nipple-sparing mastectomy and breast reconstruction, indicating that nipple-sparing mastectomy for breast cancer and breast reconstruction may be the current research hotspot. The most mature surgical robot at this stage is the Da Vinci surgical robot (Da Vinci) system developed by Intuitive Surgical of the US which is applied for minimally invasive surgery. In the future, systems comprising more durable haptic systems, more flexible machinery, and high-quality navigation will enable robotic surgery to develop into minimally invasive surgery, thereby reducing postoperative pain and improving postoperative quality of life for patients. In order to achieve broad medical application in the field of breast cancer surgery, surgical robots with more complete functions and superior affordability need to be developed. The document with the highest LCS was "Robotic nipple-sparing mastectomy for the treatment of breast cancer: Feasibility and safety study" published by the *European Institute of Oncology* in 2017. Toesca *et al.* (23) conducted nipple mastectomy and breast reconstruction surgeries on 29 patients using surgical robots to assess their feasibility, safety, and reproducibility. The results showed that the operation time was consistently short, the learning curve was fast, and no complications such as hematoma, serous, skin, or nipple-areola injuries occurred in all patients.
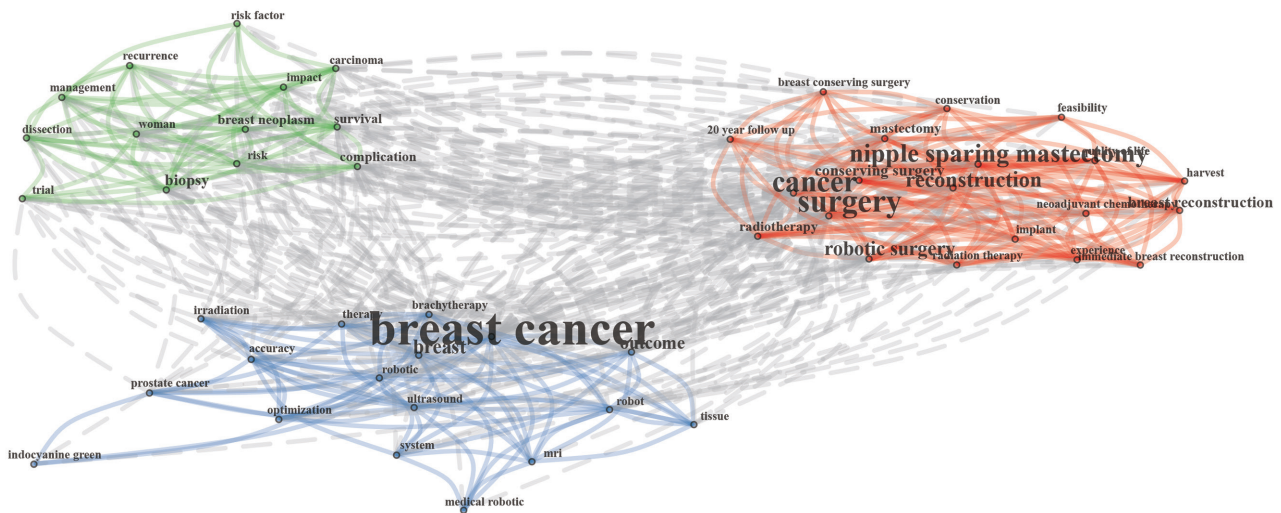
Figure 9 The co-occurrence network of the top 50 keywords with the highest frequency.
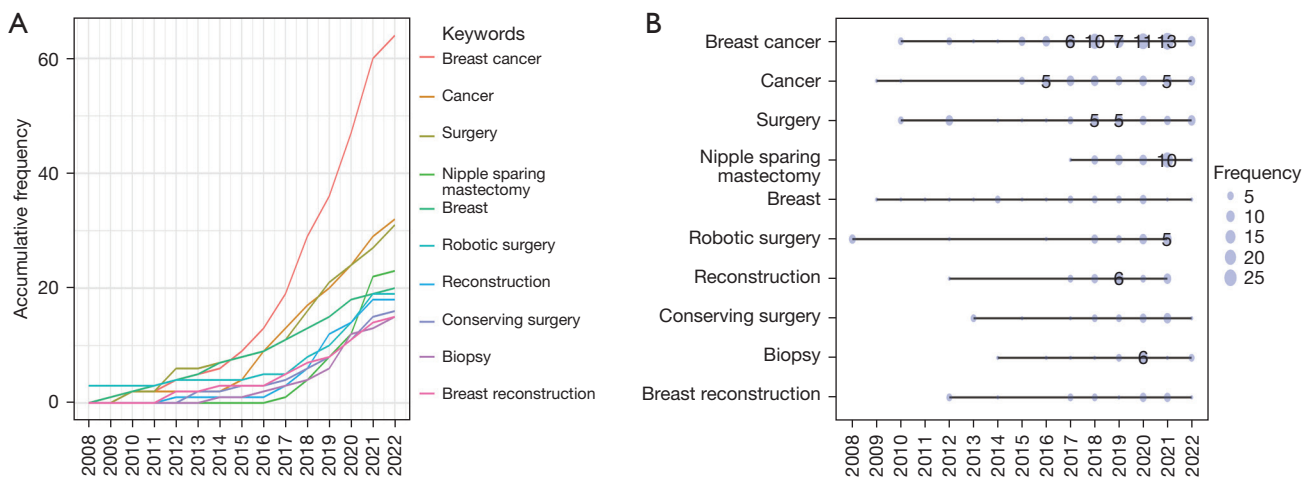

Figure 10 The temporal distribution along with the keyword contents of the topics. (A) The cumulative numbers of published articles relating to robotic surgery research in breast cancer with the top 10 keywords. (B) The annual numbers of published articles relating to robotic surgery research in breast cancer with the top 10 keywords.

This study shows that the clinical efficacy and safety of surgical robots in the treatment of breast cancer are superior to traditional surgical treatment, and it is worthy of clinical promotion. From the perspective of journal types, most of the research on the application of surgical robots to breast cancer is biased toward clinical research, and a small number of studies are biased toward the research and development of surgical robots. Considering that the application of robotic mastectomy has no obvious advantages because the breast is not a hollow organ with less

delicate surgical requirements, robotic mastectomy alone would not be permissible. However, robotic mastectomy and breast reconstruction surgery should indeed be allowed. To date, robotic nipple-sparing mastectomy and robotic harvesting of latissimus dorsi have been studied widely and made significant progress. Robotic nipple-sparing mastectomy with immediate reconstruction has been safely performed with low nipple-areolar complex ischemia and few morbidities (24,25). Also, considering that the application of robotic latissimus harvest reduced hospital
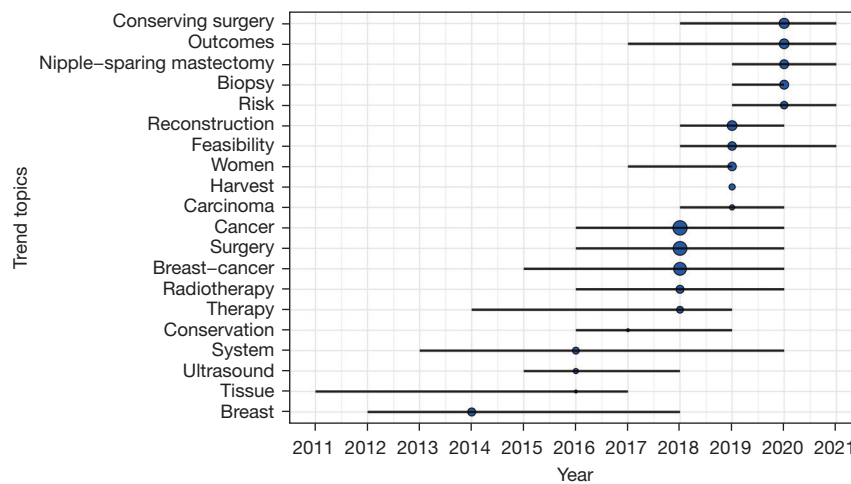
Figure 11 The hotspot pattern in keywords. The black line indicates the specific year when the frequencies of keywords appeared more than 5 times. The larger the circle, the higher the total frequency of the keyword.

stays and superior aesthetic outcomes, robotic-assisted surgery should be approved and further researched (26).

Keywords are the core summary of literature research, and the research trend represents the direction of research content in a specific time or environment, herein reflecting the general trend of surgical robots applied to breast cancer in recent years. The keyword frequency results and the co-occurrence network results indicate that the research on the application of surgical robots to breast cancer was mainly focused on related fields such as nipple-sparing mastectomy and breast reconstruction, which was consistent with the above LCS top 10 article research. The results of the temporal distribution of keywords showed that surgical robots have been a research hotspot since 2008. Although nipple-sparing mastectomy appeared later, it increased significantly in the later period and may become the next research hotspot. Keyword hotspot trends show that hotspots have grown from "breast", "tissue", and "ultrasound" to "conserving surgery" and "nipple-sparing mastectomy". Indicating that early research focused on how surgical robots are used in breast cancer patients (27,28), whereas later, surgical robots were gradually applied in breast cancer surgery, such as breast nipple-sparing excision (29,30), breast-conserving surgery (31,32), and internal mammary lymphadenectomy (33,34). In conclusion, nipple-sparing mastectomy and breast-conserving surgery may be the research hotspots in the future.

This study also had the following limitations: (I) only the core data of WoS were analyzed, and there may have been

some omissions in the included data; (II) we did not include literature with missing results, which may have led to some information loss; (III) citation time was used to evaluate the quality of publications, and the number of citations was affected by time; (IV) a small number of articles were studied, which may reduce the legitimacy of the results.

Conclusions

In this study, Bibliometricx was used to analyze the research and review literature on the application of surgical robots in breast cancer in the WoS core database. The results of the number of papers published by countries, institutions, and authors show that the US had conducted the most in-depth and extensive research on the application of robots to breast cancer and the most frequent international cooperation; studies from South Korea and China were mainly from YONSEI UNIV in South Korea and CHANGHUA CHRISTIAN HOSP. Although these institutions have published many articles, they have tended to focus on clinical and case studies, which requires further improvement. The time distribution of keywords shows that the research on the application of surgical robots to breast cancer has been carried out around keywords such as surgical robots, nipple-sparing mastectomy, and breast reconstruction. The results of keyword trend analysis suggest that nipple-sparing mastectomy and breast-conserving surgery may be future research hotspots, which is almost consistent with the conclusions of the literature

with the highest LCS. These findings can provide a certain reference for clinical and scientific researchers to understand the research status and trends of surgical robots in breast cancer.

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Footnote

Peer Review File: Available at https://gs.amegroups.com/article/view/10.21037/gs-22-540/prf

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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