Submitted: 26 April, 2022 Accepted: 09 June, 2022 Published: 15 December, 2022 DOI:10.22514/ejgo.2022.057

European Journal of Gynaecological Oncology

ORIGINAL RESEARCH

Visual analysis of minimally invasive surgery for breast cancer: a bibliometric analysis

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Abstract

Breast minimally invasive techniques are increasingly applied to breast cancer surgery, with the advantages of a small incision, minor trauma and aesthetics while treating the disease, contributing to improving the life quality of breast cancer patients. The main objective of this study was to explore and discuss the trends and hotspots in minimally invasive techniques for breast cancer surgery (MIBCS) from the last decade with bibliometric analysis, providing reference for exploration of new orientations for future research in that field. Related articles were searched from the Web of Science database, the collected data was analyzed on software to generate visualization knowledge maps. Bibliometric indicators covered publications, h-index, institutions, journals, authors, keywords, and research hotspots. China was ranked the highest for number of articles, followed by USA. The top five authors with the most publications were from Changhua Christian Hospital in Taiwan, who have contributed the most to MIBCS. The main hotspots were minimally invasive reconstruction, nipple-sparing mastectomy, and conserving surgery, with the postoperative results as the key research trend. From this study, Taiwan is the region of most contribution involving the number of publications, authors, journals, and institutions. Minimally invasive development still remains the core of MIBCS. At present, endoscopic nipple-sparing mastectomy with immediate reconstruction has been well established. Endoscopic robot assisted surgery will be tried to be adopted by more doctors. The evaluation of postoperative results will exist throughout the time.

Keywords

Breast cancer; Minimally invasive; Surgery; Bibliometric; Trend

1. Introduction

Minimally invasive breast cancer surgery (MIBCS) refers to operation on breast cancer patients with endoscopy and robotics, characterized by small incision, aesthetic and fast recovery [1–4]. Minimal invasive breast surgery conducted through a small axillary or areola incision is developing to a possible alternative to open surgery for breast cancer patients [5–8]. Benefiting from the short learning curve, the low rate of postoperative complications, and the accessibility of the laparoscopic breast technique, more and more hospitals are turning to perform it [9, 10].

Bibliometric analysis can be applied to developing and disseminate any field of research [11, 12], which also serves to provide various quantitative and qualitative indicators of the number of publications, scientific achievements, and author impact [13], showing an increasing trend to be adopted in various medical fields in recent years, as a method of assessing global research productivity [14–16]. To the best of our knowledge, bibliometrics has not been applied in MIBCS studies. Hence, the current study bibliometrics were utilized to determine trends and hotspots in MIBCS, helping researchers explore new orientations for future research in that field.

2. Materials and methods

Literature was searched from the Web of Science (WOS) database and the data was collected, with only original articles extracted. The MIBCS from 2013 to 2021 were quantified and compared by a bibliometric analysis. The database was searched using the following terms: "(TI = (Endoscopic) OR TI = (robotic) OR TI = (single-port) OR TI = (Robot) OR TI = (Laparoscope) OR TI = (Minimal Access) OR TI = ("video-assisted") AND TI = ("breast cancer"))". The analyses was realized depending on biblioshiny and VOSviewer, a tool for creating maps based on network, bibliographic, or text data [17, 18]. Biblioshiny is an R language tool program to capture the characteristics and analysis categories of MIBCS's articles, authors, journals, graphical representation, and cited references by mapping their connections from citing publications [19–22].

TABLE 1. The main information about the collection (2013–2022).

Rank	Most Cited Countries (NO.)	Annual Circulation Papers	Most Relevant Journal (articles)	Most Relevant Institution (articles)	Most Relevant Authors (articles)	Author Local Impact (NO.)
1	China (128)	2021 (11)	Cancer Research (5)	Changhua Christian Hospital (17)	CHEN ST (9)	LAI HW (38)
2	Italy (78)	2020 (11)	International Journal of Radiation Oncology Biology Physics (5)	Kaohsiung Medical University (10)	KUO SJ (9)	CHEN ST (33)
3	Japan (29)	2019 (10)	Annals of Surgical Oncology (4)	National Yang Ming Chiao Tung University (10)	LAI HW (9)	KUO SJ (30)
4	France (23)	2016 (8)	Breast (3)	Chung Shan Medical University (9)	CHEN DR (9)	CHEN DR (19)
5	Netherlands (23)	2017 (6)	World Journal of Surgical Oncology (3)	Yuanlin Christian Hospital (9)	LIN SL (9)	LIN SL (16)

3. Results

3.1 Fundamental data analysis

A total of 52 articles related to MIBCS from 2013 to 2021 were screened from the WOS database, with the Primary Information about the collection detailed in Table 1. The number of publications about MIBCS has maintained steadily increasing since 2013 (Annual Growth Rate: 7.87%), with thirteen articles in 2021. In terms of authors, Chen ST, Kuo SJ, Lai HW, Chen DR, and Lin SL published nine articles, respectively, of which the top three local Impacts of the Author are Lai HW, Chen ST, and Kuo SJ. Five articles were published in the prolific journals Cancer Research and InternationaL Journal of Radiation Oncology Biology Physics, followed by the Annals of Surgical Oncology, where published four articles. Meanwhile, fifteen countries or regions contributed to the development of this field, with China occupying the highest number of articles (30 of 54 (55%)), followed by the USA (8 pieces (14%)). The Most Cited Country is China, for 128 times. The highest average number of citations per year was 2017, reporting to be 2.7. During the study, 25 scientific institutions have published articles linked to MIBCS, where the Changhua Christian Hospital, with 17 articles (31.4%); Kaohsiung Medical University, 10 (18.5%); and National Yang Ming Chiao Tung University 10 (18.5%). The Three-fields of authors, journals, and countries is plotted in Fig. 1. On the left side of Fig. 1, a square represents an author, where larger square represents darker color, that is, more posted articles. It can be concluded from the table that the main contributing authors publishing papers related to MIBCS in Breast are all from China. The top 5 most cited articles are listed in Table 2, with the highest and lowest number to be 69 and 21, respectively, the highest average annual citation to be 7.25. 2 out of 5 highly cited articles are from authors Lai Hung-Wen.

3.2 Hotspots analysis

The keywords co-occurrence map covers 99 keywords (Fig. 2), where larger nodes represent keyword weights, the same color represents the same research hotspot, and the bigger the circle, the more frequently the keyword appears. These main areas refer to reconstruction, nipple-sparing mastectomy, conserving surgery, feasibility, outcomes, subcutaneous mastectomy, surgery, and 20-year follow-up. The growth curve of keyword frequency over time is displayed in Fig. 3, which indicates the MIBCS's research frontiers. The hotspots accumulated from keyword are distributed among reconstruction, nipple-sparing mastectomy, subcutaneous mastectomy, dissection, and conserving surgery. In Fig. 4 shows the trend transformations of topic words in over time. The theme words for 2014–2015 are treatment, lesion. And 20-year follow-up, surgery, mastectomy develop to the buzzwords for 2016–2018, during 2019–2021 turned to quality of life, reconstruction, preservation of surgery, outcome, survival. We analyzed the development trend of MIBCS through thematic cluster map (Fig. 5), with the horizontal axis for the central correlation degree, and the vertical axis for the hot word development degree. Reconstruction, nipple-sparing mastectomy, and breast-conserving surgery are the basic clustering themes. The motor theme are irradiation and survival, which marks the research frontier in the field.

4. Discussion

This study first conducts a bibliometric assessment of the worldwide productivity in the research field of MIBCS. Minimally invasive techniques are increasingly applied to breast cancer surgery [4, 23, 24], which are characterized as minor bleeding and fewer complications with aesthetic features [25, 26], involving endoscopy and Robots. In comparison with open surgery, endoscopic surgery has high safety, invasiveness and small and better cosmetic [27, 28]. We found the

TABLE 2. The top 5 cited articles in the field of MIBCS.

Rank	Article Title	Author	Journal	citation	ANC
1	Robotic nipple-sparing mastectomy for the treatment of breast cancer: Feasibility and safety study	Toesca A *et al.* [34]	Breast	69	7.25
2	Current trends in and indications for endoscopy-assisted breast surgery for breast cancer: results from a six-year study conducted by the Taiwan endoscopic breast surgery cooperative group	Lai HW *et al.* [9]	PLOS ONE	33	7.67
3	The learning curve of robotic nipple sparing mastectomy for breast cancer: An analysis of consecutive 39 procedures with cumulative sum plot	Lai H *et al.* [35]	EJSO	29	5.25
4	First-in-human robotic super microsurgery using a dedicated microsurgical robot for treating breast cancer-related lymphedema: a randomized pilot trial	Van Mulken TJM *et al.* [51]	Nature Communications	23	4.33
5	Breast cancer robotic nipple sparing mastectomy: evaluation of several surgical procedures and learning curve	Houvenaeghel G *et al.* [30]	World Journal of Surgical Oncology	21	1.44

ANC: Average annual citations.

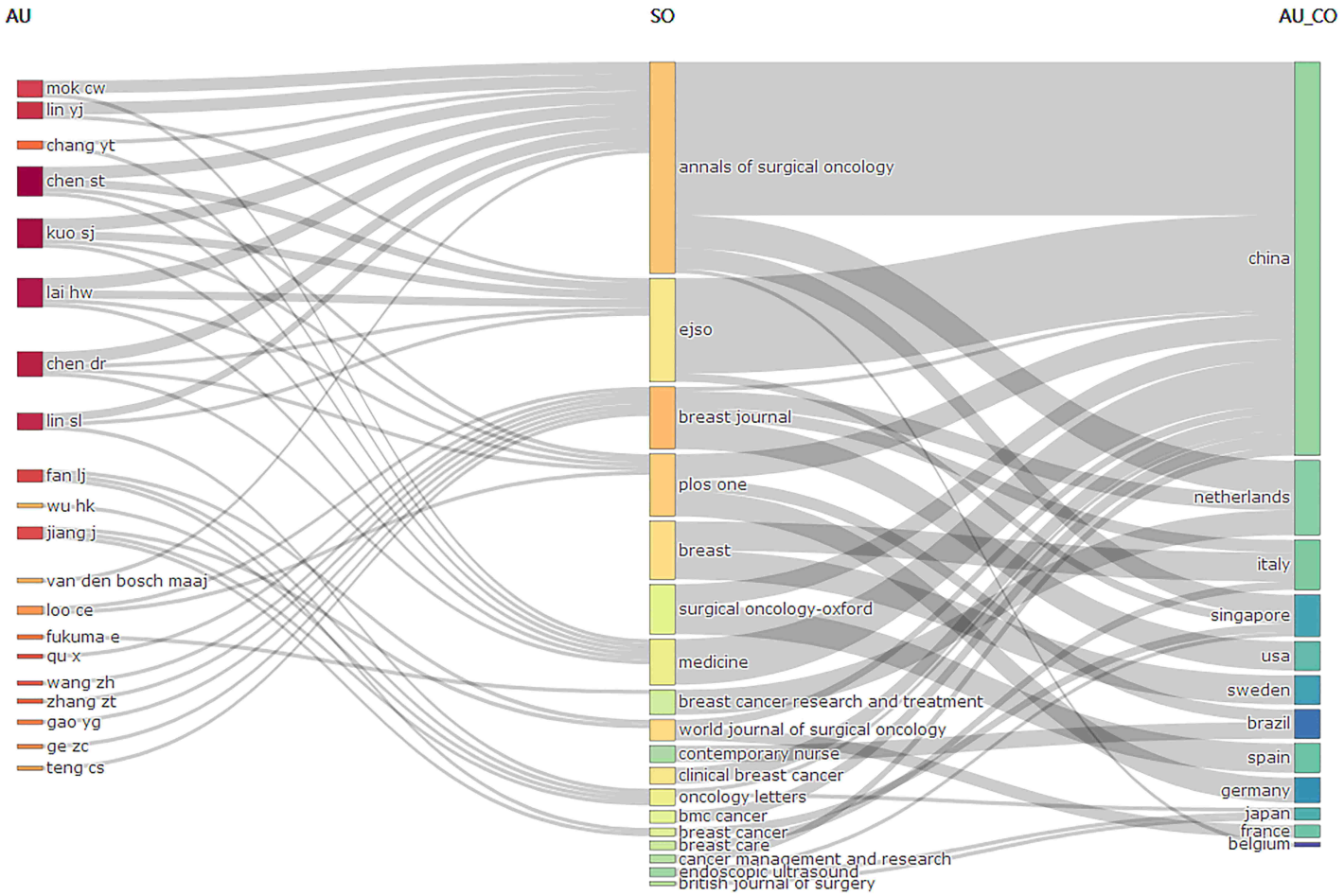

FIGURE 1. The three-fields plot of authors, journals, and countries. AU (Author); SO (Source); CO (Country).

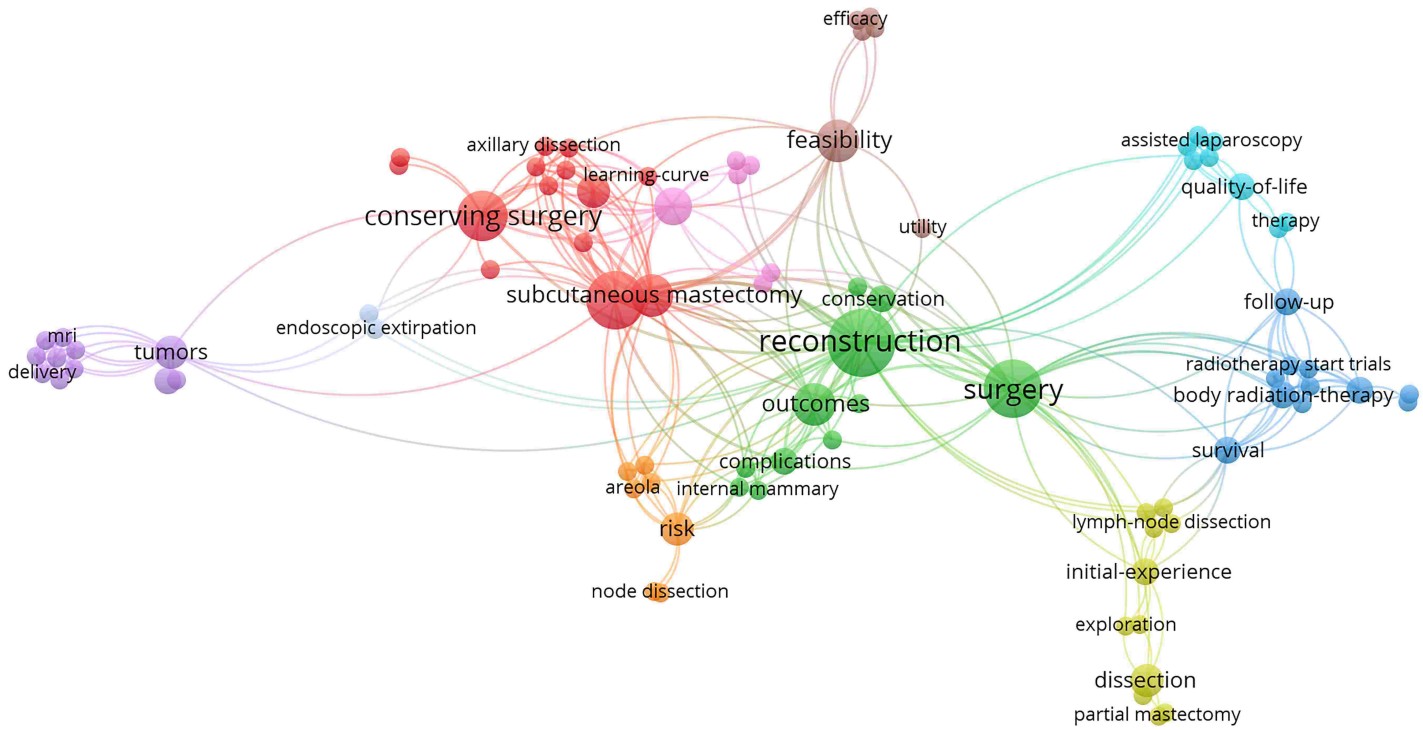

FIGURE 2. The keyword co-occurrence map.

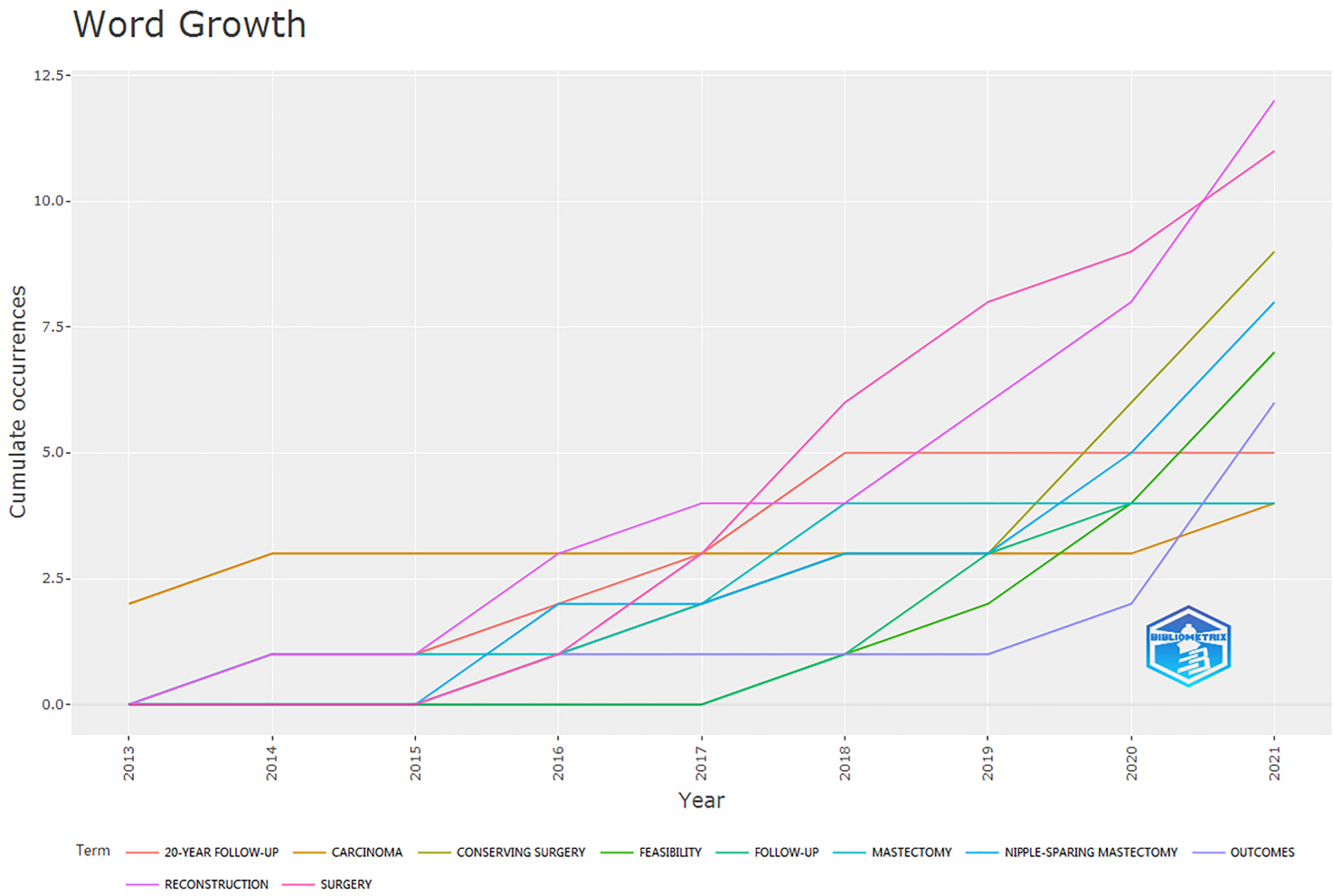

FIGURE 3. The growth curve of keyword frequency over time.

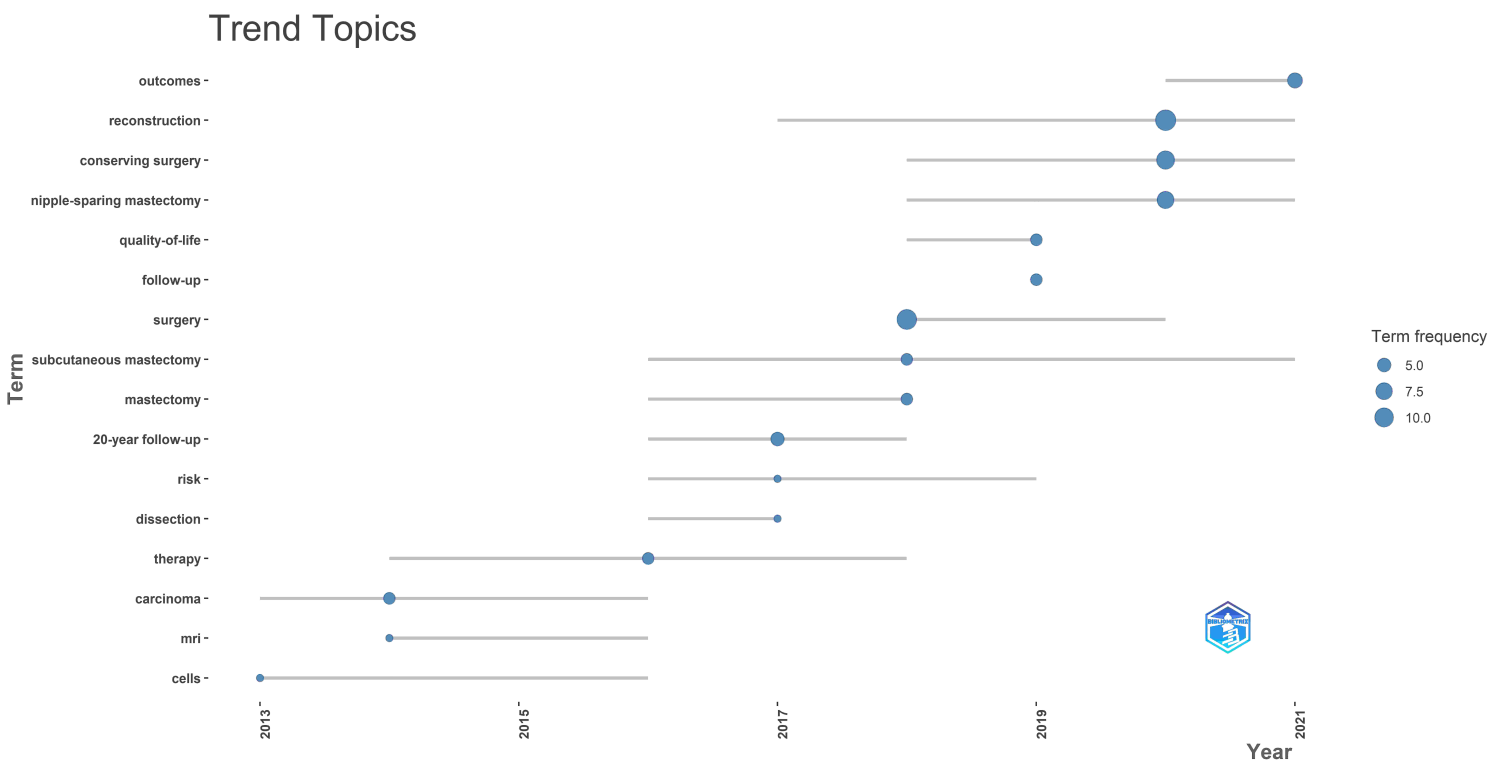

FIGURE 4. The trend changes of topic words over time.

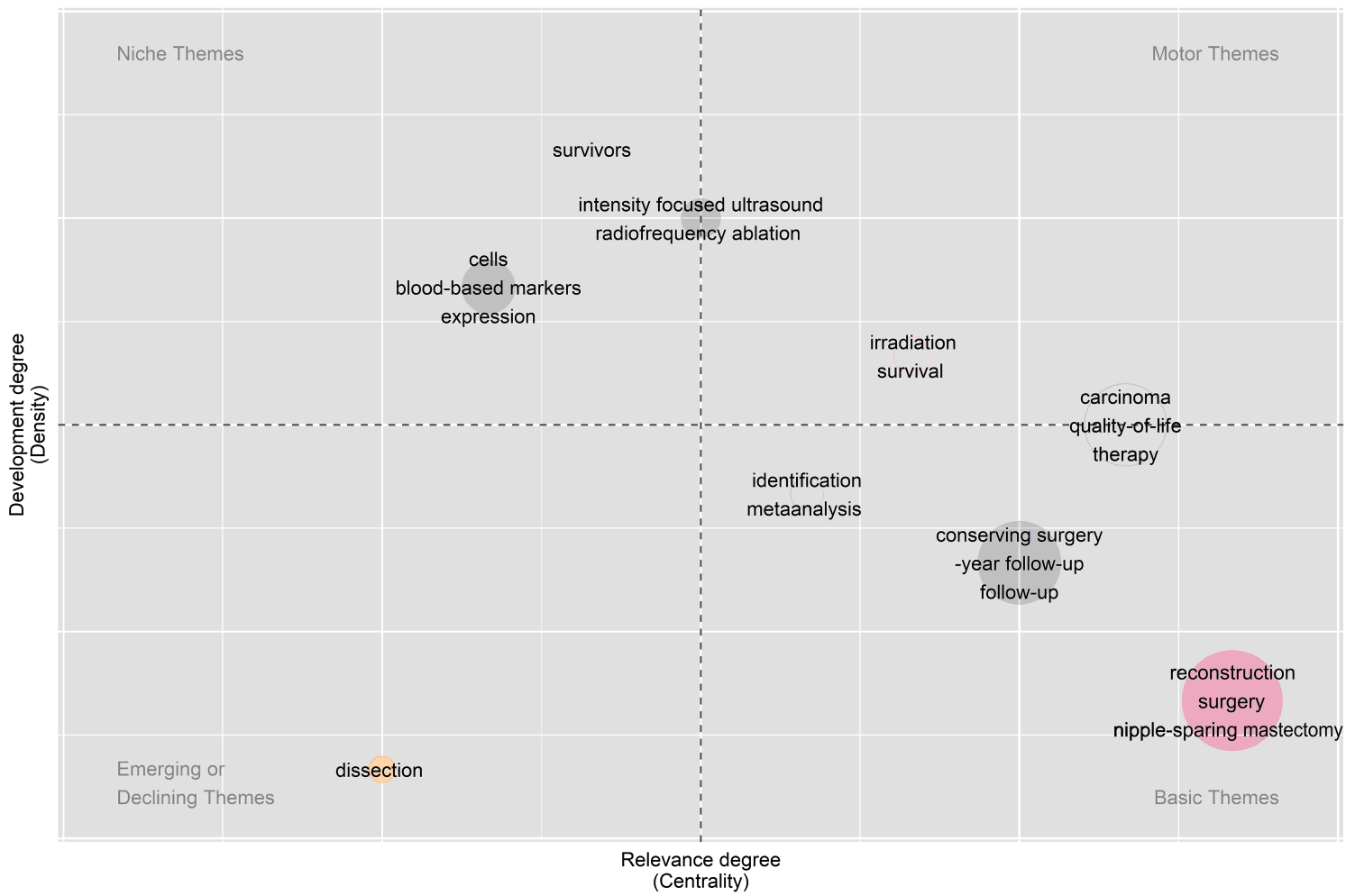

FIGURE 5. The thematic cluster map.

country with articles of highest number was China, followed by America, with the top five countries occupying 86.5% of the total compositions, as well as the top relevant research institutions. In terms of authors, the top five authors with the most publications are all from Changhua Christian Hospital in Taiwan, where the top three local impacts of authors are Lai HW, Chen ST, and Kuo SJ. In articles each generally listed the other as a co-author, which shows that the minimally invasive breast surgery team from Changhua Christian Hospital, centered on Lai HW, is well matured and produce a significant impact in the field of MIBCS. Scholars can study or exchange the knowledge of MIBCS by connecting with these authors in email. Based on the results above, Asian countries are more active in this field, possibly due to more attention from Asian doctors to the size and concealment of the incision. Of course, with the development of minimally invasive technology, European and American countries are also trying in recent years. In 2021, Mexico reported the first case of endoscopic approach to the treatment of breast cancer in their country [29]. Robotic mastectomy, as a novel approach, is also increasingly focused by some scholars, who believe that it may be the future improvement trend of breast cancer surgery [30–32]. Meanwhile, robot-assisted mastectomy is safe [33, 34], while requires a certain learning curve [35, 36], which may limit the development of robotic surgery in breast surgery to some extent.

Furthermore, the top relevant research institutions in the field of MIBCS were all from Taiwan, and this may be because the minimally invasive breast surgery has been operated earlier in Taiwan and has got a lot of financial support from the government. In addition, disparities in training in endoscopic breast surgery procedures have played a fundamental role in the development of MIBCS.

Keyword listings can efficiently identify research hotspots and provide help for research. The keyword co-occurrence graph reports the hotspots to be reconstruction, nipple-sparing mastectomy, conserving surgery, feasibility, safety and outcomes. This finding indicates that scholars in this decade have focused on minimally invasive surgery for postoperative breast cancer reconstruction, nipple-sparing mastectomy, postoperative complications, and the feasibility of endoscopic techniques in breast cancer applications, from which we learn that the mainstream procedure for minimally invasive breast cancer surgery refers to total subcutaneous mastectomy with skin preservation plus immediate breast reconstruction. Additionally, robotic nipple-preserving mastectomies and endoscopic subcutaneous mastectomy with gel (ESM + E) implants for immediate breast reconstruction are on an increasing trend [37]. Despite the prospect of minimally invasive breast surgery, long-term oncologic safety follow-up evaluations are also required [38–40]. Consequently, some surgeons choose minimally invasive techniques when faced with early-stage breast cancer patients. However, high-level evidence of endoscopic surgery for breast cancer treatment is still lacking [38]. All patients exhibited no significant difference in postoperative survival, local recurrence or distant metastasis, and postoperative complications compared with open surgery [40–43]. And the patients receiving minimally invasive surgery is also higher than those receiving open surgery [44–47]. MIBCS may take slightly longer than open surgery in terms of operating time and therefore requires formal training and a certain learning curve [30, 36]. The hotspots in the future of MIBCS may be the choice of surgical approach and autologous or prosthetic breast reconstruction. The placement of the prosthesis will more probably be placed in front of the pectoralis muscle [48–50].

5. Limitations

Firstly, only a single database was included for the bibliometric analysis. Second, articles in the database were not maintained updated, resulting in incomplete search results. Third, we only searched for titles, and there may have missed some distributed articles. Despite these limitations, our analysis provides some insight into the application of minimally invasive techniques in breast cancer surgery. Currently, the limitations of minimally invasive technique in breast cancer surgery may point to training and technology promotion.

6. Conclusion

In this study, we have pointed out several bibliometric characteristics of the minimally invasive technique in breast cancer surgery (MIBCS), providing an insight into the field trend from 2013 to 2021. Taiwan is ranked the most contributive region referring to the number of publications, authors, journals, and institutions. Endoscopic nipple-sparing mastectomy with immediate reconstruction is now well established for breast cancer patients. The hotspots in the future of MIBCS may develop to the choice of surgical approach and autologous or prosthetic breast reconstruction.

AUTHOR CONTRIBUTIONS

PFL—Writing original draft; HQ and NA—Validation; PMF—Investigation; PFL—Methodology; HQ and NA—Software; GXL—Supervision; PFL—Project administration; PMF—Interpreted of data; GXL and PMF—Review & editing.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

ACKNOWLEDGMENT

The author (Guang-Xun Lin) wishes to acknowledge the financial support of the “Xiamen Health High-Level Talent Training Program”.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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How to cite this article: Peng-fei Lyu, Hao Qin, Naer A, Guang-Xun Lin, Ping-ming Fan. Visual analysis of minimally invasive surgery for breast cancer: a bibliometric analysis. European Journal of Gynaecological Oncology. 2022; 43(6): 45-52. doi: 10.22514/ejgo.2022.057.