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A bibliometric analysis of segmentectomy versus lobectomy for non-small cell lung cancer research (1992–2019)

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Abstract

Background: This study intends to create a series of scientific maps to quantitatively estimate hot spots and emerging trends in segmentectomy versus lobectomy for non-small cell lung cancer (NSCLC) research with bibliometric methods.

Methods: Articles published on segmentectomy versus lobectomy for NSCLC were extracted from the Web of Science Core Collection (WoSCC). Extracted information was analyzed quantitatively using bibliometric analysis by CiteSpace to find hot spots and frontiers in this research area.

Results: A total of 362 scientific articles on segmentectomy versus lobectomy for NSCLC were collected, and the annual publication rate increased over time from 1992 to 2019. The leading country and the leading institution were the United States and University of Pittsburgh, respectively. Furthermore, the most prolific researchers were, namely, James D. Luketich, Rodney J. Landreneau, Matthew J. Schuchert, Morihito Okada, and David O. Wilson. The analysis of keywords pointed out that carcinoma, bronchogenic carcinoma, limited resection, segmental resection, and morbidity are hot spots and lymph node dissection, minimally invasive surgery, impact, epidemiology, and high risk are research frontiers in this field.

Conclusion: Publications related to segmentectomy versus lobectomy for NSCLC have made great achievements based on bibliometric analysis in recent years. However, further research and global collaboration are still required. Finally, we find that segmentectomy for the treatment of NSCLC is receiving much more attention from researchers globally compared with lobectomy in this research area.

Abbreviations: LLR = log-likelihood ratio, NSCLC = non-small cell lung cancer, WoSCC = Web of Science Core Collection.

Keywords: bibliometric analysis, CiteSpace, lobectomy, non-small cell lung cancer, segmentectomy

1. Introduction

Nowadays, lung cancer is the leading cause of cancer-associated deaths worldwide and it is mainly composed of small cell lung cancer and non-small cell lung cancer (NSCLC), the latter accounting for approximately 85% of all lung cancers.[1–3] Recently, more and more patients with NSCLC have been discovered with the popularity of low-dose CT screening. Currently, surgical treatment is still the preferred treatment for this cancer.[4] Lobectomy is the standard method for NSCLC based on previous clinical experience.[5] At the same time, segmentectomy is mainly treated in patients with limited cardiopulmonary function who cannot perform lobectomy.[6,7]

However, there are some meaningful controversies in terms of the scope of application of lobectomy in the treatment of NSCLC.[8,9] Some related studies have already shown that some patients can also obtain a relatively good prognosis after performing segmentectomy compared with patients undergoing lobectomy for NSCLC.[10,11] Because the patients can retain more lung function after segmentectomy, it will bring significant improvement to the patients' quality of life after surgery.[12] Nevertheless, the results of a randomized controlled clinical trial published by the lung cancer research team proved that patients with this kind of tumor undergoing segmentectomy possessed a much higher recurrence rate and a lower overall survival rate than those undergoing lobectomy.[13,14] However, the conclusion of this study has been doubted by researchers from the

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The raw data can be directly obtained from the Web of Science Core Collection (WoSCC) of Thomson Reuters.

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The datasets generated during and/or analyzed during the current study are publicly available.

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department of thoracic surgery around the world. The main reason is that wedge resection was also included in the scope of segmentectomy in this study in order to cause a problem that the classification of the surgical category was not enough clear.[15] The findings that have been published by some researchers still support the conclusion of the lung cancer research team. Besides, these researchers point out the shortcomings of segmentectomy and suggest that the clinical guidelines should establish lobectomy as the standard surgical method for NSCLC.[16] Nonetheless, the findings of other researchers have shown that, no matter whether segmentectomy or lobectomy is used to treat NSCLC, there is no significant difference in the recurrence rate or overall survival rate of patients.[17,18] Thence, segmentectomy is a valuable surgical method of treatment for patients with this kind of tumor based on these research results.[19]

As a result, there are still many arguments given the role of segmentectomy versus lobectomy for patients with NSCLC. Then, we will conduct a bibliometric analysis to explore the global research situation in order to achieve a scientific overall view in this research field using CiteSpace.[20] CiteSpace is an information visualization software based on Java language, and it can obtain a scientific knowledge map through visualization methods, thereby presenting the structure, discipline, and distribution of scientific knowledge, and further revealing new trends and new developments in scientific development hidden in the publications. On this basis, we are able to further understand collaborative relationships, the hot spots, and research frontiers on this topic. Moreover, we believe that the information sorted by CiteSpace will play a significant positive guiding role for follow-up researches from this time forward in this field.[21]

2. Material and methods

We selected the Web of Science Core Collection (WoSCC) of Thomson Reuters as our database for this bibliometric analysis. The search parameters were: (Segmentectomy AND Lobectomy AND [non-small lung cancer OR NSCLC]); time span: 1992 to 2019; literature type: Article; index: sci-expanded; language: English. All of retrieval work was carried out on March 31, 2020 so as to avoid changes caused by daily updates to the database. The data are all secondary data and does not contain any personal information, so informed consent was not required.

WoSCC is a database that provides online scientific citation indexing services. All records (include titles, authors, sources, abstracts) and references that we stored from database were exported in plain text format. CiteSpace is a Java application software developed by Dr Chen Chaomei, a scholar at Drexel University, and applied to visual analysis of documents. The software can obtain metrological information such as historical development, research hotspots, and trends in the research field after analyzing a large number of literatures with similar research topics.[22] In addition, the software also supports various types of bibliometric researches, including cooperative network analysis, co-citation analysis, etc. Due to its rich bibliometric analysis functions, CiteSpace has been widely used in different research areas and the version 5.6.R2 is used for bibliometric analysis in this study.

The data collected from 1992 to 2019 on the study of segmentectomy versus lobectomy for NSCLC was imported into CiteSpace 5.6.R2 and no duplicate records were found. The length of the study was divided into 7 parts, 4 years per slice. This research mainly aimed to analyze the cooperation network (including countries, institutions, and authors), co-occurrence keyword, co-citation reference, and so on.

3. Results

3.1. Distribution characteristic of literatures

From 1992 to 2019, a total of 362 publications on segmentectomy versus lobectomy for NSCLC were found. The first article published on the topic was in 1992, so the starting point for the inclusion of the literature was 1992. Figure 1 shows the amount of papers issued in each year. Before 2000, no >5 articles were published in this field. From 2001 to 2009, the growth trend of the annual number of publications was also not obvious. However, there was a rapid growth rate of the number of literatures from 2010 to 2019, and a total of 291 publications were found during this period, accounting for 80.4% of the total number of articles. In addition, the annual number of papers published reached a peak in 2019 with a total of 46 articles.

3.2. The analysis of countries, institutions, and authors

Figure 2A depicts a network map of cooperative countries involved in this research area. The size of node represents the number of publications issued by a specific country and the thicker line indicates the frequency in cooperation between countries. The purple circle is the marker in the network map and it can make us easier to identify pivotal countries that have made greater contributions in this research field. As shown in Fig. 2A, it is worth noting that although some countries contribute few papers in this research field, they work closely with other countries. For example, Switzerland owns only 5 published literatures, but it maintains rather closely relationship in cooperation with France and Germany, respectively.

The map network of cooperative institutions related to this research area has been shown in Fig. 2B. A total of 98 research institutions have published scientific papers in segmentectomy versus lobectomy for NSCLC research in the past 28 years according to our analysis using CiteSpace. The size of node indicates the number of articles published by a specific institution and the thicker line reveals the frequency in cooperation between institutions. Nodes with purple circles represent institutions with rather high influence in this research field. According to Fig. 2B, the major institutions working with the University of Pittsburgh are University of Virginia, University of Washington, University of Vanderbilt, University of Cincinnati, and Boston Medical Center. Table 1 shows the top 10 most active research institutions and these research institutions account for 28.7% of the total

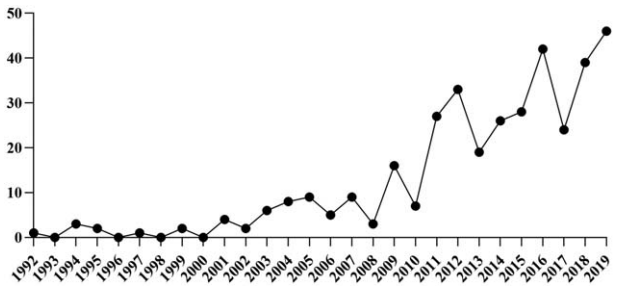

Figure 1. Annual output of segmentectomy versus lobectomy for non-small cell lung cancer research from 1992 to 2019.

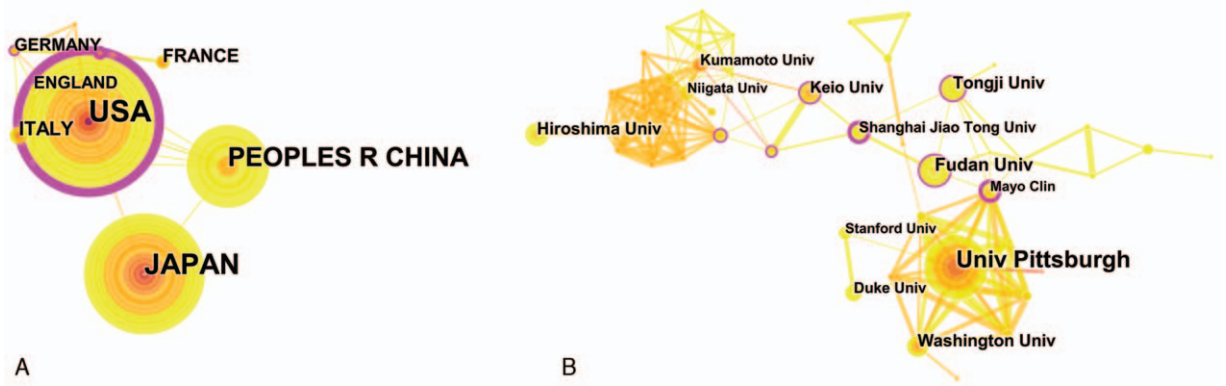

Figure 2. A. The analysis of countries. Network map of country cooperation in segmentectomy versus lobectomy for non-small cell lung cancer research from 1992 to 2019. B. The analysis of institutions. Network map of institution cooperation in segmentectomy versus lobectomy for non-small cell lung cancer research from 1992 to 2019.

number of publications. Among these institutions, University of Pittsburgh ranks first in the number of papers (n = 25), followed by Fudan University (n = 12), University of Washington (n = 10), Hiroshima University (n = 10), Tongji University (n = 10). Besides, 3 research institutions are from the United States, 3 are from China, 3 are from Japan, and only 1 is from France. In addition, 8 institutions are universities, and the other 2 are hospitals. The index, centrality, represents the influence of institution in a quantitative way. The highest ranking of centrality is Shanghai Jiao Tong University (centrality, 0.26), followed by Mayo Clinic (centrality, 0.25), Tongji University (centrality, 0.14), Fudan University (centrality, 0.12), and Keio University (centrality, 0.12). It is worth noting that 3 universities from China rank in the top 10 in terms of the number of publications and centrality simultaneously. They are, namely, Shanghai Jiao Tong University, Tongji University, and Fudan University. Furthermore, Keio University from Japan also possesses the characteristics mentioned above.

During the research period, a total of 87 authors have published influential studies on this research topic. Figure 3 is a network map of cooperative authors involved in this field, where each node represents an author. The size of the node represents the number of articles published by the author in the research field. The degree of thick line between the connecting nodes represents the frequency of collaboration between authors. In addition, authors who have frequent collaborations on articles will automatically form a closer team. According to Fig. 3, the cooperative relationship between the authors who care about this clinical research topic has not formed a huge influential research team temporarily. The main reason is that most of researchers only seek partners in their own research institutions. In light of the amount of publications, it is worth noting that there are 3 authors who have published >15 papers, namely, James D. Luketich (n = 19), Rodney J. Landreneau (n = 18), and Matthew J. Schuchert (n = 15). However, the centrality of these authors is rather low, further indicating that the level of cooperation between authors is rather insufficient. Table 2 shows the top 10 most active authors and their affiliates from 1992 to 2019. Among these authors, 5 are from the United States, 4 are from Japan, and only 1 is from China.

Table 1

Top 10 institutions that published literatures in segmentectomy versus lobectomy for non-small cell lung cancer research from 1992 to 2019.

Rank	Institution	Publications	Centrality
1	University of Pittsburgh	25	0.06
2	Fudan University	12	0.12
3	University of Washington	10	0.02
4	Hiroshima University	10	0.00
5	Tongji University	10	0.14
6	Keio University	8	0.12
7	Institut Mutualiste Montsouris	8	0.00
8	Hyogo Med Ctr Adults	7	0.00
9	Shanghai Jiao Tong University	7	0.26
10	Duke University	7	0.00

3.3. The analysis of keywords

Figure 4A is a network map of keyword co-occurrence, where there are 101 crosses and 257 links. Each cross represents the frequency of keyword appearing in the topic articles of our research. The larger the cross, the more clinical researches on the subject surrounding the specific keyword. The thicker the line between the keywords, the higher the frequency of this group of keywords appearing in the clinical articles. Besides, keywords with a purple circle take on much more important roles in the research of lobectomy versus segmentectomy for NSCLC. Through the rapid identification of these keywords, it can help us quickly identify the hot topics studied in the literature. Furthermore, we select keyword as label and use the log-likelihood ratio (LLR) algorithm to generate a cluster map of co-occurrence keywords, as shown in Fig. 4B. The LLR algorithm has been widely used in similarity modeling calculations for data mining. In this cluster analysis, the modularity Q value is 0.7071 and the mean silhouette value is 0.815, indicating that this cluster that we obtained is an obviously independent, and the label of each cluster is relatively accurate.[23] In addition, there are 10 clusters in total, and the name of each cluster is determined according to the number of items. After this analysis, we can further determine the specific categories with an overview of this research derived from all keywords. The clinical significance of the cluster map of co-occurrence keywords is that each cluster includes several different keywords for the subtheme of the study. Therefore, it can provide a convenient approach to help

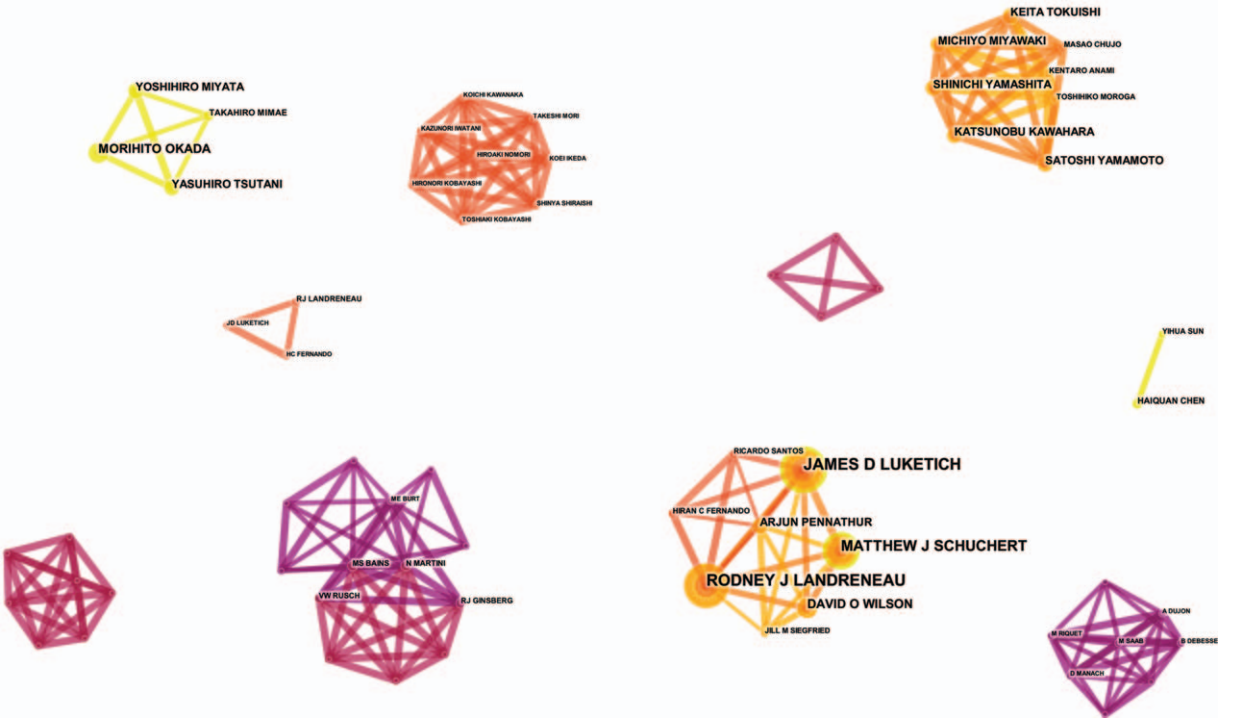

Figure 3. The analysis of authors. Network map of author cooperation in segmentectomy versus lobectomy for non-small cell lung cancer research from 1992 to 2019.

researchers who are concerned about the subtheme of this research field to quickly identify that which other relevant keywords are included in the subtheme that they do concern from a global perspective. For example, cluster #0 is named after mortality and those top-ranked keywords inside cluster #0 deserve much more attention for clinical researchers who are concerned about the subtopic of this study. These keywords are computed tomography, phase II, stage IIIa, and ground-glass opacity (Fig. 4B).

In the analysis of keywords with the strongest citation bursts according to Fig. 5, carcinoma (strength, 8.4569) is the most intensive keyword in the research field of segmentectomy versus lobectomy for NSCLC from 1992 to 2007, followed by bronchogenic carcinoma (strength, 6.7257), limited resection (strength, 3.7402), segmental resection (strength, 5.5220), morbidity (strength, 4.3026). The clinical significance of Fig. 5 is that it can display the detailed time span of research hotspot of the top keywords with the strongest citation bursts accurately in this study, thereby helping researchers sift out the keywords that locate in the frontier of this research field. For instance, researchers insist on paying more attention to outcome of segmentectomy versus lobectomy for NSCLC from 2017 to 2019 (Fig. 5).

Moreover, Fig. 6 is a timezone diagram of keywords. The timezone view focuses on exploring the changes of keywords in the research field from the time dimension. All keyword nodes are located in a 2-dimensional coordinate with the horizontal axis as time. At the quoted time, the nodes are located in different time zones and follow the time axis upwards in turn, forming a left-to-right and bottom-up keyword evolution map. The number of links between the keyword nodes determines the strength and inheritance of the relationship between the 2 keywords. Besides, there are 7 keywords in the frontiers of research of segmentectomy versus lobectomy for NSCLC circled by a black circle

Table 2

Top 10 authors contributing publications in segmentectomy versus lobectomy for non-small cell lung cancer research from 1992 to 2019.

Rank	Author	Publications	Institution	Country
1	James D. Luketich	19	University of Pittsburgh	USA
2	Rodney J. Landreneau	18	University of Pittsburgh	USA
3	Matthew J. Schuchert	15	University of Pittsburgh	USA
4	Morihito Okada	8	Hyogo Med Ctr Adults	Japan
5	David O. Wilson	8	University of Pittsburgh	USA
6	Gening Jiang	7	Tongji University	China
7	Thomas A. Damico	6	Mount Sinai School of Medicine	USA
8	Katsunobu Kawahara	6	Oita University	Japan
9	Michiyo Miyawaki	6	Oita University	Japan
10	Yasuhiro Tsutani	6	Hiroshima University	Japan

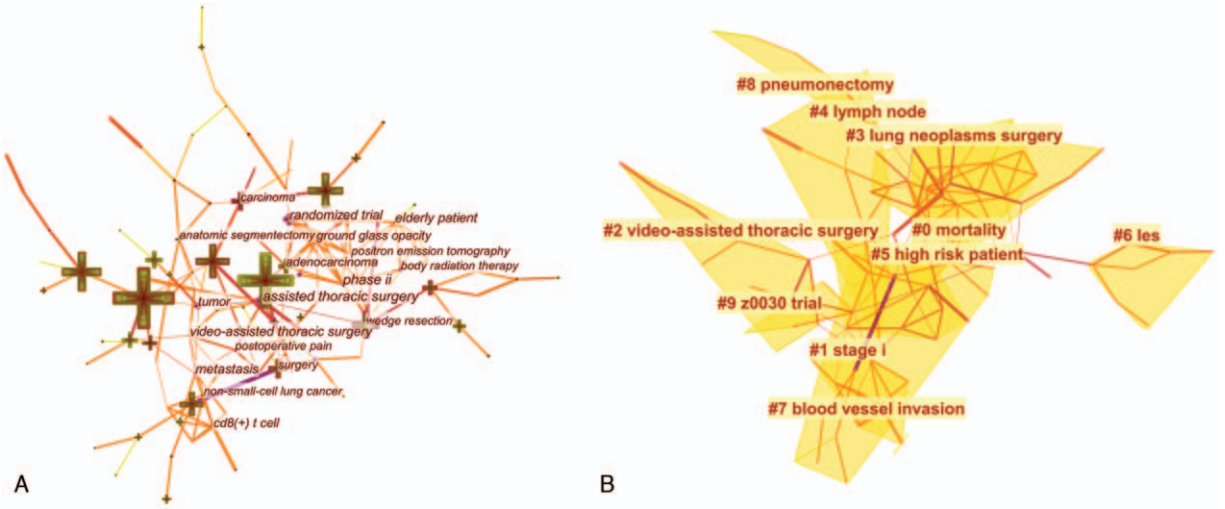

Figure 4. The analysis of keywords. A. The co-citation map of keywords from publications in segmentectomy versus lobectomy for non-small cell lung cancer research from 1992 to 2019. B. Cluster view of co-cited keywords in segmentectomy versus lobectomy for non-small cell lung cancer research from 1992 to 2019.

according to Fig. 6. They are lymph node dissection, minimally invasive surgery, meta-analysis, impact, epidemiology, NSCLC, high risk, respectively. Among all of keywords, the highest the amount of co-citation is the impact.

3.4. The analysis of references

CiteSpace 5.6.R2 is used to analyze 362 records retrieved from WoSCC to detect the intellectual landscape in this research area. Figure 7A is a network map of co-citation references in this field, where are 131 nodes and 206 links. According to Fig. 7A, the size of node represents the number of the specific publication has been cited. The more the literature is cited, the larger the diameter of the node. Besides, it is worth noting that there are nodes with a purple circle, indicating that these literatures can be considered as the foundation publications of this research field. The thickness of the line between nodes can explain the frequency of citations of these 2 documents at the same time. Table 3 summarizes the top 10 literatures according to the count of co-citation, including author, title, year of publication. Furthermore, we also list the top 10 published articles by centrality, as shown in Table 4. Centrality is a quantified index, which means the greater the centrality one article owns, it plays a vital role in the specific area. Especially, when combining Tables 3 and 4, we find 3 references have high centrality and the high frequency of co-citation at the same time. They are Wisnivesky JP, 2010, Ann Surg, Schuchert MJ, 2007, Ann Thorac Surg, and Nakamura K, 2010, Jpn J Clin Oncol, respectively.

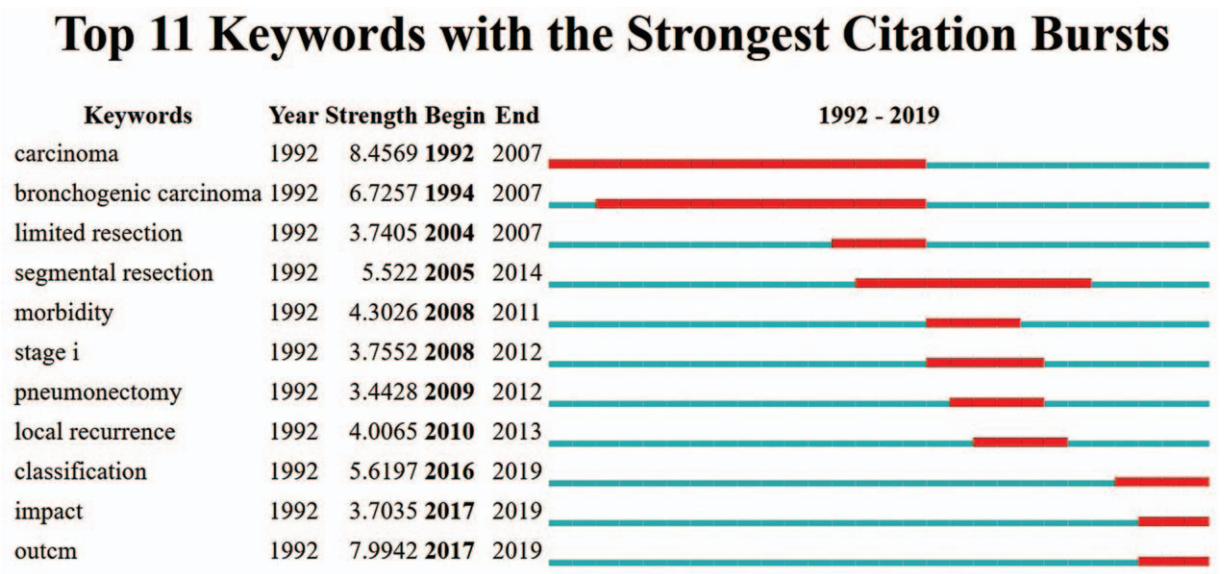

Figure 5. The keywords with strongest citation bursts from publications in segmentectomy versus lobectomy for non-small cell lung cancer research from 1992 to 2019.

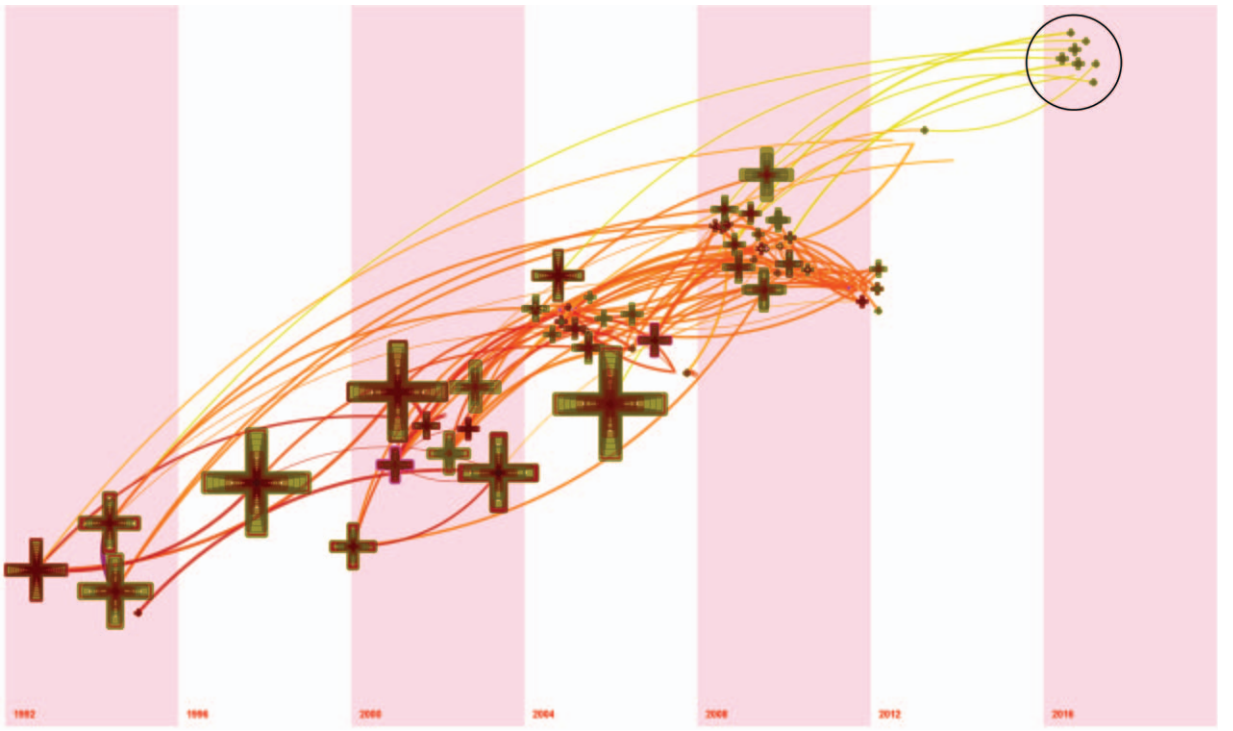

Figure 6. Timeline view of co-cited keywords from publications in segmentectomy versus lobectomy for non-small cell lung cancer research from 1992 to 2019.

Similarly, we also select keyword as label and use the LLR algorithm to generate a cluster map of co-citation references, which is one of important techniques in data mining, as shown in Fig. 7B. In this cluster analysis, the modularity Q value is 0.8288 and the mean silhouette value is 0.7571, which means that the consequents in the cluster map are also clearly defined. A total of 10 clusters are formed, and the name of each cluster is decided according to the number of items as well. The importance of the analysis of the cluster map of co-citation references is that each cluster includes a series of references with similar research subtheme and it also provides a pathway for researchers who are concerned about the subtheme of this research area to quickly identify valuable publications in the specific field they focus on. For example, cluster #3 is named after minimally invasive surgery with more meaningful references being Greenlee RT, 2000, CA-Cancer J Clin, Scott WJ, 2007, Chest, and Sawabata N, 2004, Ann Thorac Surg.

4. Discussion

In the research area of segmentectomy versus lobectomy for NSCLC, the number of publications increases with a stable trend recently. Therefore, it can be expected reasonably that the prospects of development in this field are considerable. The first article on this topic we retrieved was published in The Annals of Thoracic Surgery by Martini et al[24] in 1992 and proposed that in stage II carcinomas, resection remained the treatment of choice, that mediastinal lymph node dissection provided the most

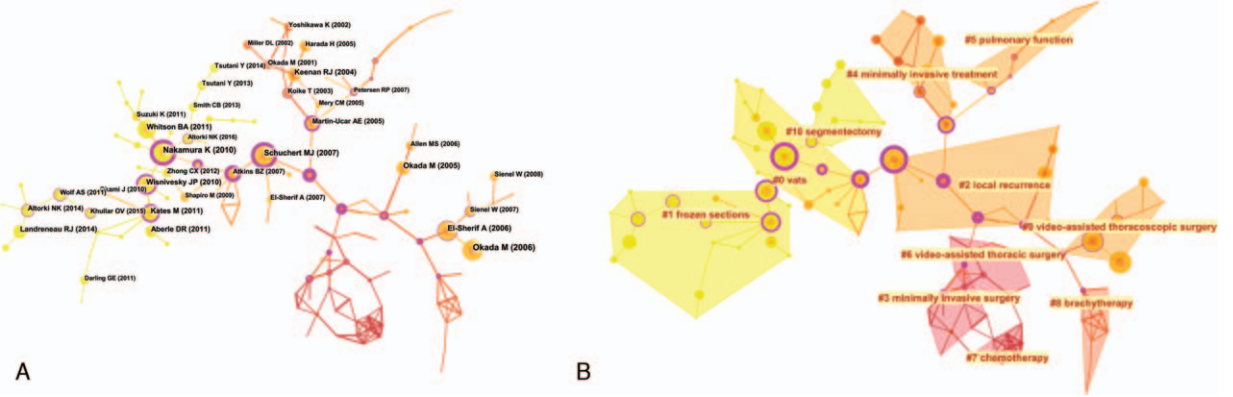

Figure 7. The analysis of references. A. The co-citation map of references from publications in segmentectomy versus lobectomy for non-small cell lung cancer research from 1992 to 2019. B. Cluster view of co-cited references in segmentectomy versus lobectomy for non-small cell lung cancer research from 1992 to 2019.

Table 3

Top 10 co-cited references sorted by the count of co-citation in the study of segmentectomy versus lobectomy for non-small cell lung cancer research from 1992 to 2019.

Rank	Count	References	Cluster no.
1	56	Okada M, 2006, J Thorac Cardiov Sur, V132, P769	9
2	43	Nakamura K, 2010, Jpn J Clin Oncol, V40, P271	0
3	40	Schuchert MJ, 2007, Ann Thorac Surg, V84, P926	2
4	39	Okada M, 2005, J Thorac Cardiov Sur, V129, P87	9
5	37	El-Sherif A, 2006, Ann Thorac Surg, V82, P408	9
6	33	Keenan RJ, 2004, Ann Thorac Surg, V78, P228	4
7	33	Whitson BA, 2011, Ann Thorac Surg, V92, P1943	0
8	31	Landreneau RJ, 2014, J Clin Oncol, V32, P2449	6
9	30	Kates M, 2011, CHEST, V139, P491	0
10	29	Wisnivesky JP, 2010, Ann Surg, V251, P550	1

accurate staging, and that the best adjuvant treatment to improve survival was yet to be determined. This is the main reason why we set the starting point of article retrieval time as 1992, so the time span of the literatures we retrieved is rather sufficient. Since then, researchers begin to pay much more attention to this field and explore deeply research from various perspectives gradually.[25]

In the analysis of country cooperation, China is a developing country among the top 10 countries, and the remaining 9 countries are all developed countries. It can be seen that China is rather concerned on the development of this field. In general, the number of articles published by developed countries in this research field is quite high. It is noteworthy that although Japan has contributed a large number of publications, its centrality is not enough notable. In contrast, the country, Switzerland, although owns just few articles, its centrality is impressive, indicating that Switzerland focuses on quality of literatures rather than quantity. In addition, the United States, Germany, England, and China not only concern the number of papers, but focus on improving the quality of articles.

Among these research institutions, University of Pittsburgh has been the leading institution in segmentectomy versus lobectomy for NSCLC research with a total of 25 articles. Although University of Pittsburgh has already taken advantages in the number of published papers, its centrality is not as prominent as Fudan University. Of the top 10, 7 institutions are from developed countries, and the rest are all in China. It can be seen that this research area has attracted the attention of research institutions globally. In particular, Fudan University is worth being paid more attention by experts in this research field. Because it does not only increase the amount of literatures, but its centrality is also quite high indicating that it has made significant progress in this research area. At present, the cooperation between institutions has not yet formed a particularly obvious international collaborative group, which indicates that institutions following with great interest in this field should strengthen cooperation in the next few years.

The top 10 authors who have published more than 15 articles are James D. Luketich, Rodney J. Landreneau, and Matthew J. Schuchert in this research field, respectively. Luketich et al[28] believe that segmentectomy can achieve similar results compared with lobectomy for patients with NSCLC, by analyzing the recurrence rate of the 2 operations (14.0% vs 14.7%, $P=1.00$).[26,27] Based on this research, they also propose that it is necessary to carry out prospective research to describe the potential advantages of segmentectomy.[28] Furthermore, Landreneau et al[29] insist that there is no difference in the survival rate of IA stage after 2 surgical methods, but the survival rate of patients in stage IB is slightly worse.[25] Additionally, Schuchert et al[30] reckon that when the tumor diameter is <1 cm or less and the pathological stage is stage IA, the therapeutic effects of segmentectomy and lobectomy are comparable.[31] However, further prospective research assessing the effectiveness of these treatments is required in order to inform future practice.[32]

The path finding algorithm is used when we analyze the feature of keywords and the function of this algorithm is effectively able to simplify the network map and highlight its important characteristic of keywords.[23] Burst keywords are considered to be appropriate indicators of the research frontiers. Comprehensive analysis of the 11 emerging keywords with strongest citation bursts detected by CiteSpace. As shown in Fig. 5, we find

Table 4

Top 10 co-cited references sorted by centrality in the study of segmentectomy versus lobectomy for non-small cell lung cancer research from 1992 to 2019.

Rank	Centrality	Reference	Cluster no.
1	1.10	Fernando HC, 2005, J Thorac Cardiov Sur, V129, P26	2
2	1.04	Okada M, 2003, Cancer, V98, P535	9
3	0.88	Schuchert MJ, 2007, Ann Thorac Surg, V84, P926	2
4	0.86	Atkins BZ, 2007, Ann Thorac Surg, V84, P1107	2
5	0.82	Nakamura K, 2010, Jpn J Clin Oncol, V40, P271	0
6	0.72	Watanabe A, 2009, Eur J Cardio-Thorac, V35, P775	0
7	0.62	Sagawa M, 2001, Ann Thorac Surg, V71, P1100	3
8	0.55	Sawabata N, 2004, Ann Thorac Surg, V77, P415	2
9	0.47	Martin-Ucar AE, 2005, Eur J Cardio-Thorac, V27, P675	4
10	0.43	Wisnivesky JP, 2010, Ann Surg, V251, P550	1

that they are all elaborated from the 4 aspects, including research objectives, tumor grades, surgical methods, and outcome indicators. For instance, carcinoma and bronchogenic carcinoma belong to the direction of research objectives; Classification and stage I belong to the direction of tumor grades; segmental resection, limited resection, and pneumonectomy belong to the direction of surgical methods; and outcome, morbidity, local recurrence, and impact belong to the direction of outcome indicators.

For the analysis of cluster of co-citation keywords, modularity Q and mean silhouette are two indexes provided by CiteSpace based on the network structure and the clarity of cluster, which can be used as the basis for researchers to evaluate the rationality of clusters.[33] Generally, modularity Q value >0.3 means that the divided community structure is significant and mean silhouette value >0.5 means that cluster is considered as reasonable. According to the parameter of cluster map of co-citation keywords provided by CiteSpace, modularity Q value is 0.7071, mean silhouette value is 0.8145. Here, LLR algorithm is also used for calculation of cluster of co-citation keywords, which is consistent with our research purposes. In addition, the color of node is purple that refers to a larger (not <0.1) centrality.

Furthermore, we analyze the characteristics of co-cited reference based on Fig. 7 in order to rapidly clarify crucial direction of research hotspots. Next, when combining Tables 3 and 4, there are 3 publications with high centrality and the count of co-citation at the same time, including Nakamura K, 2010, Jpn J Clin Oncol (43, 0.82), Schuchert MJ, 2007, Ann Thorac Surg (40, 0.88), and Wisnivesky JP, 2010, Ann Thorac Surg (40, 0.88). A study of Nakamura et al[34] showed that there was a difference in the postoperative overall survival rate, the main outcome indicator, for patients with early peripheral NSCLC with a tumor diameter of <2 cm after segmentectomy and lobectomy. In addition, it was a Phase III clinical trial. Further research by Schuchert et al[35] insisted that lobectomy still should be regarded as the primary surgical choice for patients with NSCLC and the intraoperative lymph node status and surgical margin were needed to be fully evaluated. However, anatomical segmental resection may be particularly useful for small tumors with a diameter of <2 cm within the boundary of the anatomical segment, and elderly patients with impaired cardiopulmonary function.[30,36] Finally, ground glass-like shadows and lesions showing bronchoalveolar histology may also be ideal targets for segmental resection because of their low metastatic potential.[31,37]. It was necessary to explore a prospective randomized study to comprehensively illuminate the role of segmental resection relative to lobectomy in patients with NSCLC.[38] Wisnivesky et al[39] considered that their research results suggested that survival rate of patients older than 65 years age undergoing limited resection or lobectomy for stage IA tumors ≤ 2 cm appeared to be similar.[40] Although prospective studies were required to further confirm these findings, our results suggested that limited resection may be an alternative treatment option for patients with tumor at least. Overall, the disciplinary perspectives mentioned above are important landscapes for this research field.

The advantages of this study are as follows. First of all, as far as we know, this is the first study using bibliometric method to analyze segmentectomy versus lobectomy for NSCLC research over the past 2 decades. Secondly, the time span of our literature retrieval is sufficient, even including the first paper published in 1992 in this research area. However, there are also some deficiencies in this study. We only retrieve publications from the WoSCC database, and the amount of literatures we collect is not rather large. The results presented in our study still need to be confirmed by more relevant researches in the future. Furthermore, some literatures published in non-English language are also excluded from this study. Moreover, the data type of this study only follows closely interest with the article. Finally, this study mainly focused on quantitative analysis, qualitative analysis is slightly insufficient.[36]

5. Conclusion

A considerable number of publications related to segmentectomy versus lobectomy for NSCLC have made great achievements based on bibliometric analysis. The growth rate of the number of articles published in this field will increase gradually from this time onward. Overall, the cooperation between countries, institutions, and authors still has not formed the influential group, which suggests that the whole world should further strengthen international collaboration to promote progress in this research direction. Especially, authors and institutions from the United States, Japan, or China should take responsibility for establishing the relationship of global cooperation. In addition, we found that segmentectomy for the treatment of NSCLC is receiving much more attention from researchers globally compared with lobectomy in this research area based on our analysis. However, more relevant studies are still needed in the future to further confirm the advantages of segmentectomy in the treatment of NSCLC.

Author contributions

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