Bibliometric and Visual Analysis of Laparoscopic Surgery

Li-Ren Liou[1,2,*], Yu-Lung Wu[3], Lin Hsiao Man[4,5]

[1] Department of Information Engineering, I-Shou University, Kaohsiung City 84001, Taiwan;
+886970741442;Allenliou@LIVE.COM

[2] Division of Surgery, Zuoying Branch of Kaohsiung Armed Forces General Hospital,
Kaohsiung City 813204, Taiwan;+886970741442; Allenliou@LIVE.COM

[3] Department of Information Management, I-Shou University, Kaohsiung City 84001, Taiwan;
+886-7-6577711;wuyulung@isu.edu.tw

[4] Department of Information Engineering, I-Shou University, Kaohsiung City 84001, Taiwan;
+886-7-6577711;Lin220541@yahoo.com.tw

[5] Division of Rehabilitation, Zuoying Branch of Kaohsiung Armed Forces General Hospital,
Kaohsiung City 813204, Taiwan+886-7-6577711;Lin220541@yahoo.com.tw

Abstract

The development of laparoscopic surgery, an operation performed in the abdomen through the use of microscopic incisions, can be proven repeatedly through the effectiveness of the surgery and its superiority. However, because of the existence of many abdominal illnesses, laparoscopic surgery has yet to be considered a standard treatment. Because of this, this study focuses on the Web of Science Core Collection database as a subject, making use of its incredible features to retrieve, save, manage and review information and explore blanket data on laparoscopic surgery. On the other hand, bibliometrics is employed via VOSviewer's cluster modeling technology, using clustering and mapping features to model the importance of the literature data structure and relationship, and how they can be displayed in vector spaces to showcase trends in how knowledge structures change through clear, intuitive, and colorful graphs. As evidenced by brand-new science and technology, this will pinpoint the direction that laparoscopy's future development will take.

Keywords: *laparoscopy, bibliometrics, visualized analyses, VOSviewer*

1. Introduction

In the early 20th century, laparoscopy was used mainly to inspect human organs and to diagnose illnesses. It wasn't until the 1980s when the first case of a gallbladder removal surgery via laparoscopy happened, and with the successful completion of the operation, laparoscopic surgery as a procedure began to flourish. Apart from constant reform and the development of improved

surgical instruments, its scope of use advanced to the treatment of other organs in the abdominal cavity across nearly three decades' time. From a diagnostic perspective, laparoscopic surgery is capable of achieving the goal of observing organs inside humans with the least amount of trauma. From a surgical standpoint, it not only reduces the size of the operations' incisions, the damage caused to a patient's body is also minimized, and compared to a traditional laparotomy, the level of pain in surgical wounds post-operation is significantly lower, with a lower chance of complications. Compounding upon everything mentioned above, laparoscopic surgery has played a key role in the revolutionary development of surgical medicine.

On the other hand, Alan Pritchard proposed using bibliometrics in 1969, which is used to understand the structure and process of how science evolves, defining it as "the application of mathematics and statistical methods to the internal structure of written information and presenting scientific qualities and development trends through digitalization." This study uses the bibliometric network system, VOSviewer, sorting via internet connection through the most authoritative published works in the Web of Science database and cluster-analyzing oft-cited literature, authors, and periodicals in the field of laparoscopic surgery to better understand the subjects' composition traits, including through the literature, writers, research topics and research methods, etc. We probe the direction that academic development is taking by comparing trends and summaries of different periods and looking at the relationship between cited work, cross-subject collaborations, and the impact of research results in each field of study to explore the research staffs' core topics and key issues.

Additionally, we also used knowledge graph quantification and qualitative analysis to analyze keywords used in papers published in leading journals to see how its core of study developed and its distinguishing features to ensure a better grip on the way laparoscopic surgery progressed and to understand research hotspots and their evolution over time, to provide references for medical professionals in diagnosis and treatment.

2. Methodology

2.1 The sources for the research data

The data for this study was mainly collected from the most influential papers from some 178 branches of science in the Web of Science Core Collection's Science Citation Index Expanded (SCI-Expanded, circa 1900), rigorously reviewed and inspected by experts, with a standardized index and a complete editorial process, to maintain the quality of the research data and meet requirements from authorities. An advanced search to retrieve laparoscopic surgery-themed periodical indexes included all books and summarized author records (number of published pieces, times cited, H index and times of self-citation etc.), using the global research data as a source to improve the efficacy and efficiency of this study, at the same time meeting the data needs for multivariate data analysis.

For this study, the subject of laparoscopic surgery and titles with laparoscopic surgery are the search perimeters, with the timeframe set from 1990 to September 2022 in the Web of Science Core Collection database, the publication type set to articles, and after choosing authors

and the choice of formatting for cited references, the search came up with 8,210 published articles, with all data downloaded, including authors, titles, summaries and works cited, downloaded as a download*.txt file, converted, and then saved.

2.2 Content Analysis

Articles on laparoscopic surgery can be analyzed visually through the VOSviewer Version 1.6.18 software, using the system's various features and options to choose different analyzation features and conduct a time series analysis on the most cited works to present the optimal online analysis results, with the scope of research displayed in Figure 1.
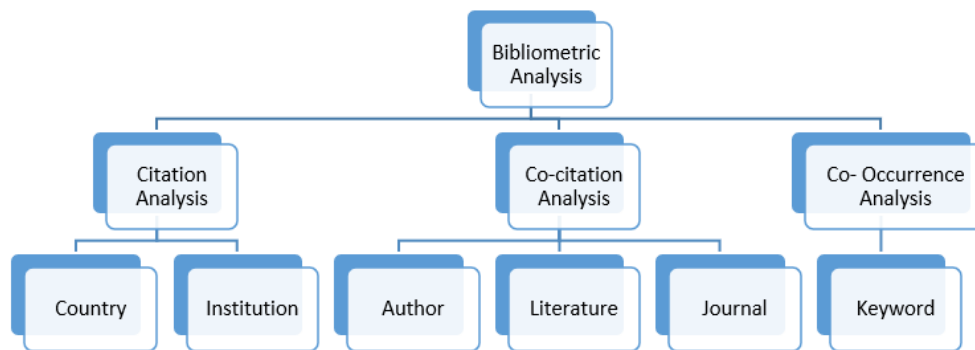

Fig 1. Scope of research

3. Results

3.1 Cluster analysis according to nation

The circles' colors (warm colors > cool colors) and sizes indicate the distribution of cited articles and their weight. From Figure 2, we can see that there are four clusters for the collaborative relationships between nations studying laparoscopic surgery. Cluster one is red (with 11 items), including Australia, Austria, Brazil, the UK, Germany, Greece, India, Ireland, Israel and the US that show closer collaboration. Cluster 2 is green (10 items), including Belgium, Finland, France, Italy, the Netherlands, Norway, Scotland, Spain, Switzerland and Thailand, who work together closely. Cluster 3 is blue (9 items), including Denmark, Japan, China, Poland, Singapore, South Korea, Sweden, Taiwan and Turkiye, who enjoy good collaborative relationships. Cluster 4 is yellow (1 item), with Canada found in close collaborations. The VosViewer software's analysis on the nations' published work count and quality can be seen in Figure 3.
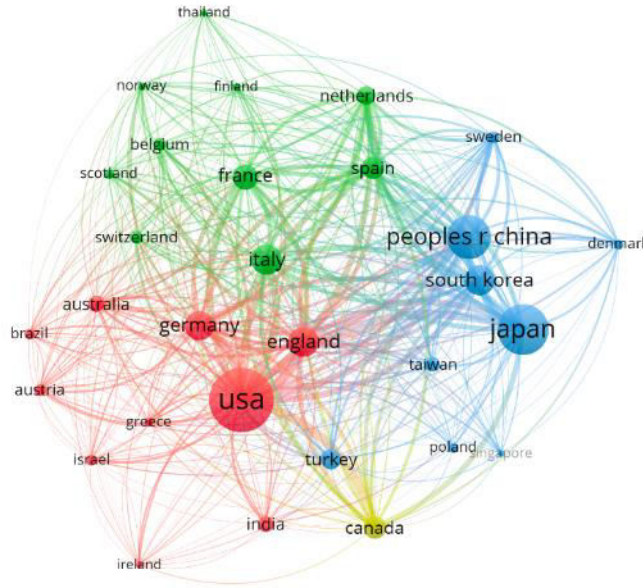
Fig 2. Laparoscopic surgery - Cluster Analysis by Nation - Network visualization.
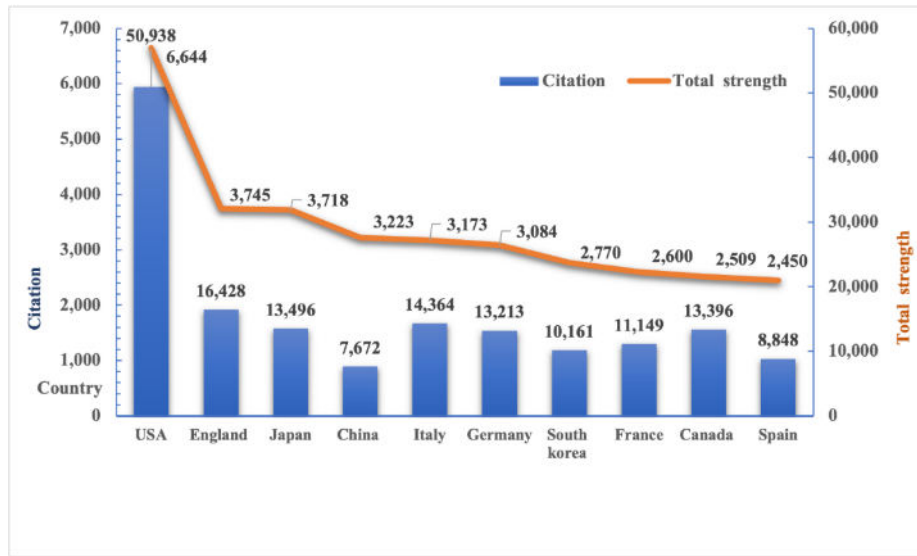

Fig 3. laparoscopic-each nation's published work count and the strength of citations

3.2 Cluster analysis by organization

Shown in Figure 4 is the knowledge output on laparoscopic surgery and the current distribution of its academia, with results showing that the research institutions are divided into eight major groups. We can see the organizations' published work count and work quality through the VOSviewer software's analysis (Figure 5), with the National Cancer Center in the lead and South Korea's Seoul National University ranked next. The others, listed in order, include: Cleveland Clinic Foundation, the University of Leeds, and the Imperial College London.
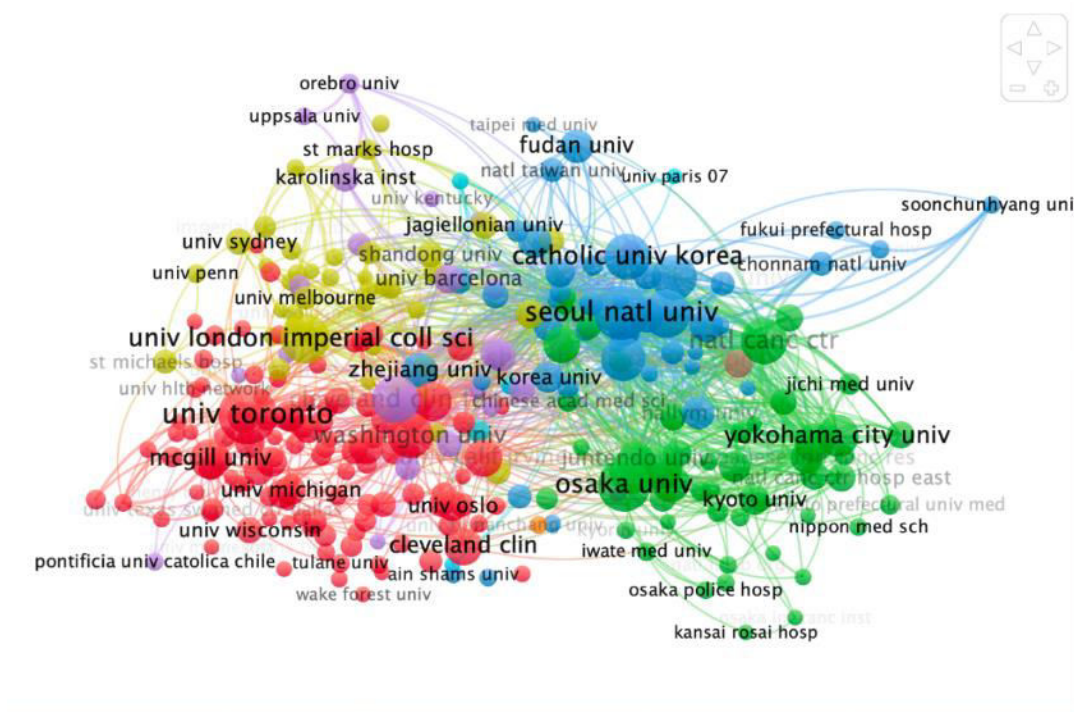
Fig 4. Laparoscopic surgery cluster analysis by organization - Network visualization.
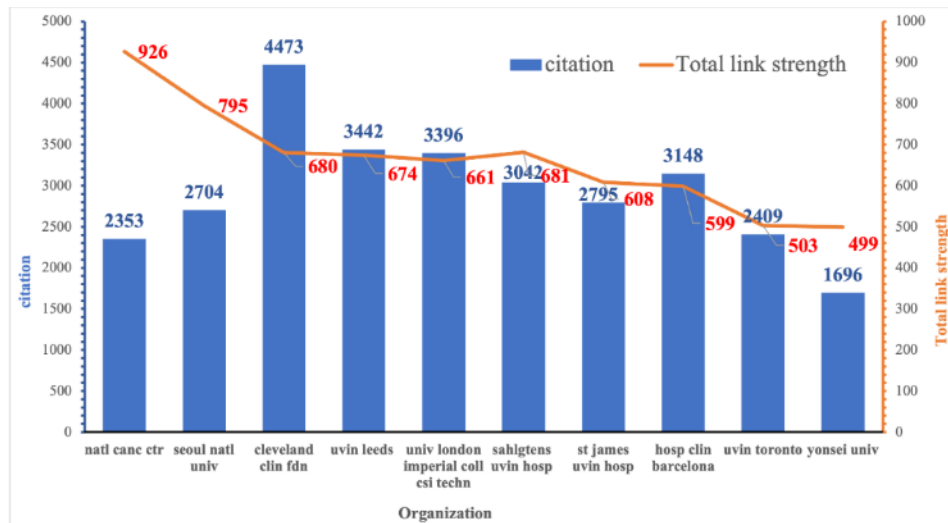

Fig 5. The research institutions published work count on laparoscopic surgery and times cited

In the analysis on the countries' and institutions' cited works, the US and European countries have published the most articles when looking at laparoscopic surgery publications and the capacity distribution. The US takes up 26% of the world's publications, Italy comes next at 8%, then Germany and England both at 7%. In Asia, Japan is in the lead at 17% for the number of works published, with China coming in next at 14% and South Korea at 7%. In the analysis, one can also see that, no matter the relationship between nations or organizations, there is a strong positive correlation with the region or language family.

3.3 The authors' co-citation relationships

There are nine groups in all (Figure 6), VOSviewer's author co-citation density map (Figure 7) indicates the strength of the collaborations between authors and the excellence seen in their academic performances. The distribution of collaborative relationships moves from the yellow area (higher importance) to the blue area (lower importance). For instance, in the obviously yellow area, there are researchers H. J. Bonjer, H. Nelson and A. M. Lacy, all key writers in the field of laparoscopic surgery research.
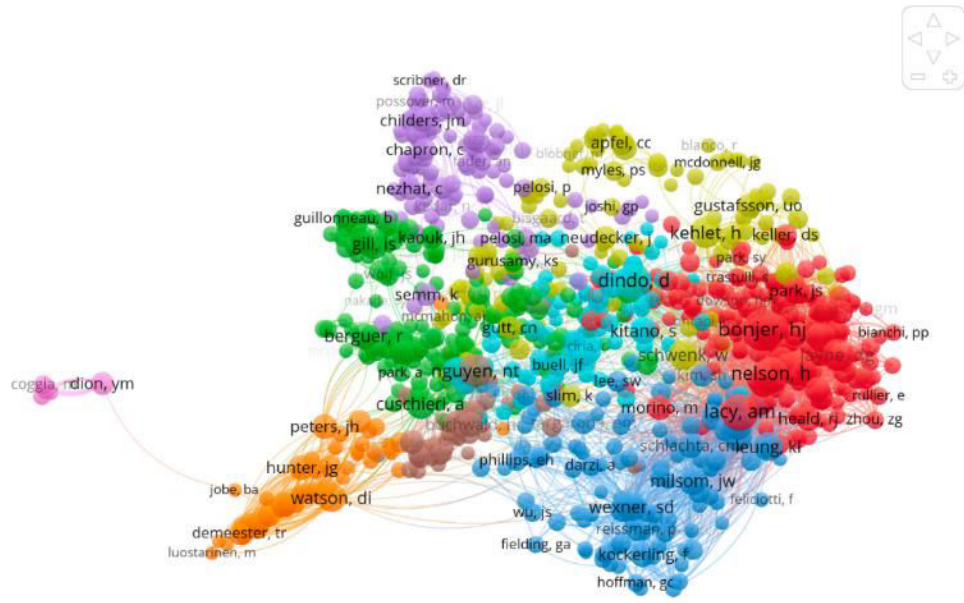

Fig 6. Cluster analysis of authors' co-citations - Network visualization
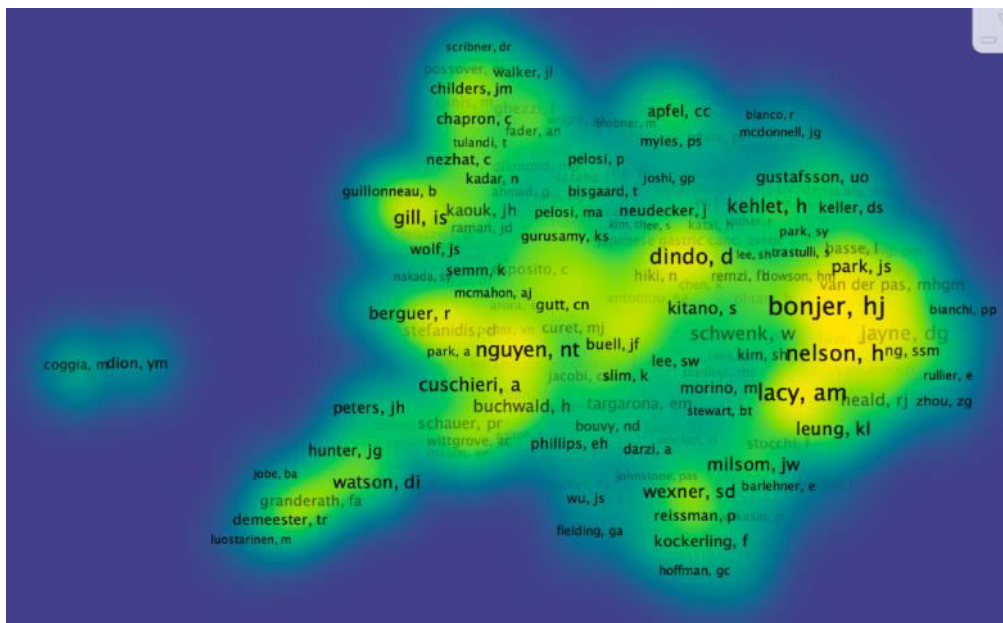

Fig 7. Cluster analysis of co-cited authors - Density visualization

3.4. Co-citation of articles

Divided into 5 groups (Figure 8), Table 1 is listed in the order of co-citation relationships in laparoscopic surgery articles. For example, H. Nelson's (2004) works were cited 551 times, its connection strength being 2,931; Guillou P. J.'s (2005) articles were cited 509 times with a connection strength of 2,904; Lacy A. M.'s (2002) was cited 415 times with a connection strength of 2,383; Bonjer H. J. (2005) was cited 379 times, with a connection strength of 2,148, etc.
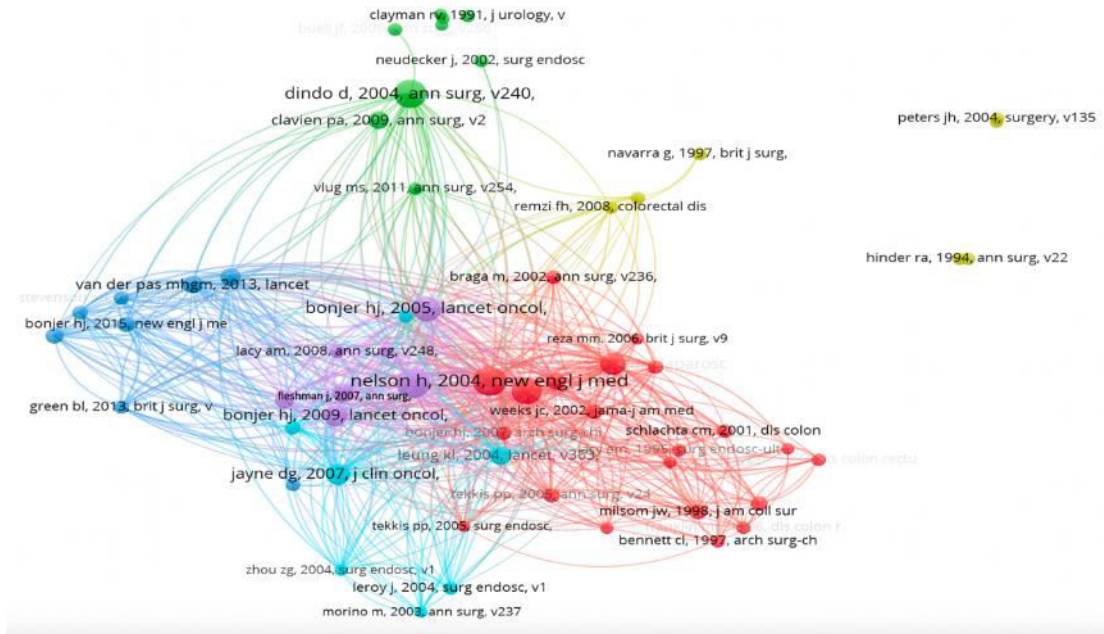

Figure 8. The cluster analysis of co-cited laparoscopic surgery papers

Table 1. The strength of co-cited laparoscopic surgery papers

Reference		
Reference	Citation	Total link strength
Heidi Nelson, 2004 ,N Engl J Med. DOI: 10.1056/NEJMoa032651	551	2,931
Guillou, P. J., 2005. lancet. doi.org/10.1016/S1470-2045(05)70221-7	509	2,904
Lacy, A. M., 2002,Lancet. doi.org/10.1016/S0140-6736(02)09290-5	415	2,383
Bonjer, H. J., 2005, Archives of surgery . DOI: 10.1001/archsurg.142.3.298	379	2,148
Jayne ,D.G, 2007, j clin oncol.DOI: 10.1200/JCO.2006.09.7758	269	1,420
Jacobs, M., 1991, surg laparosc endosc, v1, p144, PMID: 1688289	230	2,064
Bonjer, H. J., 2009, lancet oncol, doi.org/10.1016/S1470-2045(08)70310-3	229	1,935
Fleshman,J., 2007, ann surg, DOI: 10.1097/SLA.0b013e318155a762	172	1,666
Leung, K.L., 2004, lancet, https://doi.org/10.1016/S0140-6736(04)15947-3	172	1,642
Kang, S.B., 2010, lancet oncol, doi.org/10.1016/S1470-2045(10)70131-5	154	1,391

Regarding the authors' co-citation relationships, the analysis comes down to the epitome of social collaborations, meaning the direct or indirect ways to participate in one or multiple

institutions when they collaborate. From the most scientific of standpoints, observing the similarities and strengths of connections between clusters can be used to evaluate various academic achievements and the performance of social roles (Mulyawati & Ramadhan, 2021). In the author co-citation analysis, the three authors that came out on top are H. J. Bonjer, H. Nelson, and A. M. Lacy as the most cited, whose works were also cited the most; this is to explore how laparoscopic surgery compares to the application of colorectal surgery and the traditional laparotomy.

3.5. Co-citation of periodicals

There are eight groups (Figure 9), with Figure 10 showing, in order, the co-citation relationships in laparoscopic surgery periodicals.

Fig 9. Cluster analysis of laparoscopic surgery periodicals - Network visualization
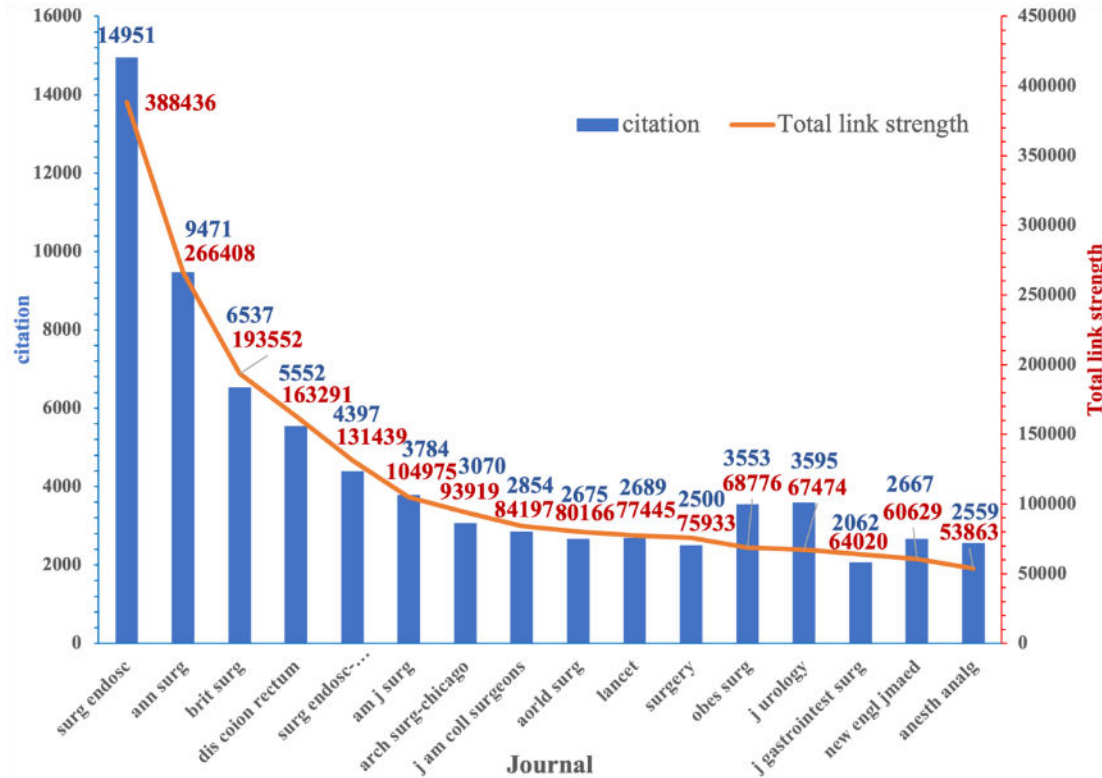
Fig 10. Co-citation strength of laparoscopic surgery periodicals

The number of times an article and journal have been co-cited reflects the amount of attention this article is receiving from other researchers, as well as its influence on other fields of academic research (Durieux & Gevenois, 2010). Likewise, the more often an article is cited, the more lauded it is for the knowledge or technology it generates among later generations of researchers. From the analysis on article co-citation, one can see that the top three most co-cited articles are all based on the comparisons between laparoscopic surgery, colorectal surgery, and the traditional laparotomy.

3.6. Analysis of co-occurring keywords

There are nine groups, as shown in Figure 11. The number of keywords found in laparoscopic surgery articles is listed according to timing as shown in Figure 12, indicating the hotspot distribution of the study, as well as showing how the clusters' colors correlate to the timing when the papers were recorded. The size of the circles is shown according to the weight of the keywords, and their colors indicate the average time for impact. The closer the nodes are, the stronger the relationship is, ranging from dark blue to yellow.
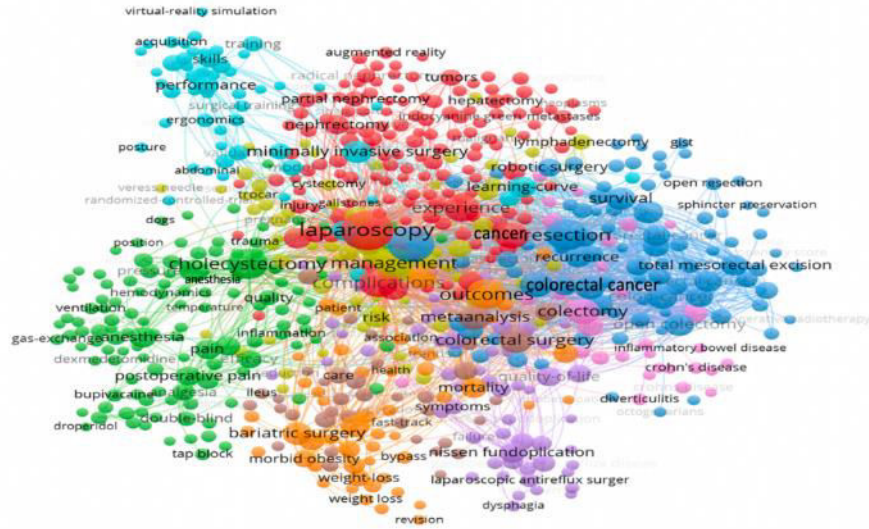
Figure 11. The analysis of co-occurring laparoscopic surgery keywords - Network visualization
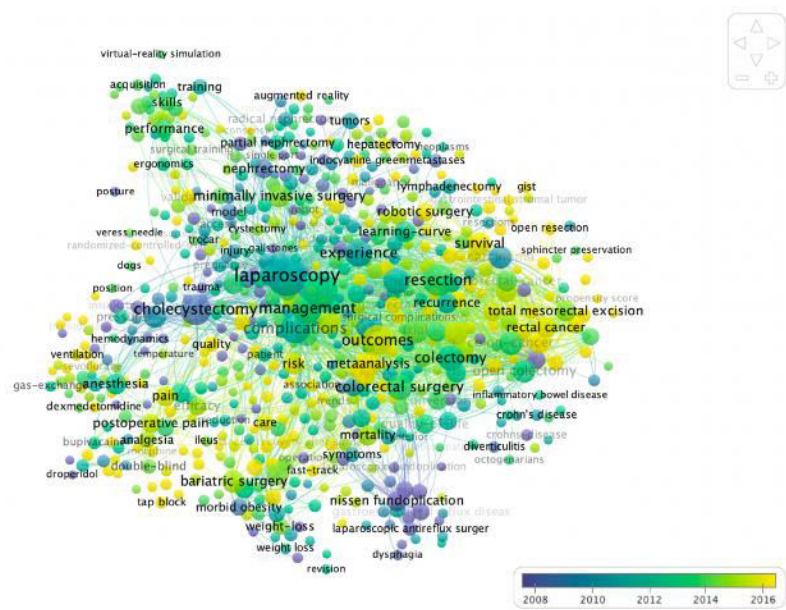

Figure 12. Analysis of laparoscopic surgery keyword timing - Overlay visualization

Keywords are the essence to an article's content. Judging by the strength of the connection between keywords, one can distinguish which research topics and developmental issues that call for urgent solutions that experts are most interested in across different time zones(Liao, H,2018). This study identifies research fields and hotspot analysis according to the distribution of co-occurrence frequency in keywords, as shown in Figure 13.
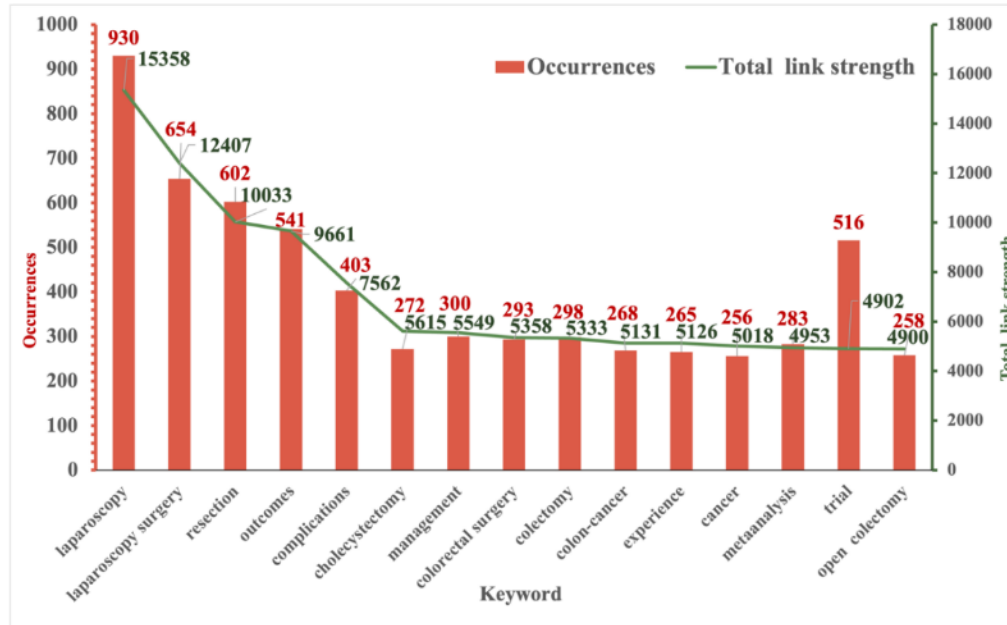
Fig 13.The strength of co-occurrence in laparoscopic surgery keywords

Regarding the analysis of co-occurring keywords, the analysis explores how in earlier years, laparoscopic surgery is applied in the cholecystectomy, nephrectomy, and Nissen fundoplication, and its physiological effects, and between 2010 and 2014, focuses on the study of laparoscopy, techniques involved, experiences and its complications, etc. After 2016, the studies revolve around meta-analysis, outcomes, pain, and survival.

4. Conclusions

Academic research on laparoscopic surgery and its clinical application are mostly comprised of case reports or comparisons of clinical practicality and traditional operations, and there is little research done with knowledge graph quantification for published works. Because of this, effective means are lacking for comparisons and can easily result in biased or unbalanced study results. This study employs the periodicals containing laparoscopic surgery papers and data from the Web of Science database, utilizing the VOSviewer modeling for clustering technology (Van Eck & Waltman, 2010) and integrates data analysis via cluster analysis technology and graphic demonstration technology, discovering the most impactful works published in the field of laparoscopic surgery studies, as well as the key turning points in the evolution of the literature, thus parsing through the entire scheme of development and following up to explain the trends and situation in different time periods.

The visualized data analysis of quantitative laparoscopic surgery papers have reached these conclusions: first, within the network of collaborations between nations and institutions, the US and European countries have close collaborative relationships, and vice versa for the Asian countries of this study. Second, as seen from the changes in the co-citation dynamics structure, prominent authors and papers with stronger connection strengths can be seen in the co-cited

author analysis or co-cited paper analysis, all of which discuss the use of laparoscopy in hemicolectomy and colorectal surgeries; papers that study the use of laparoscopy in other abdominal visceral organ operations, such as laparoscopic gastric, pancreatic, and liver surgeries, are significantly less discussed and cited than the former. Third, analyzing the co-occurrence of keywords shows how, in earlier years, the focus was on transitioning from traditional surgery to laparoscopic surgery; between 2010 and 2014, the focus shifted to discussing how surgical techniques can be improved to avoid complications, and after 2016, the studies revolve around post-surgery patient survival rates and prognosis. Experts in relevant fields who are to analyze laparoscopic surgeries in the future will be able to work beyond regional and linguistic barriers by referencing papers written by other experts, and zero in on issues other than hemicolectomy and colorectal surgeries, looking at different kinds of laparoscopic surgeries, what skills and techniques are involved and the complications and prognosis of these surgeries, to establish more standardized methods in conducting abdominal operations via laparoscopy, something that could potentially become a focus in the field's future research.

REFERENCES

1. Mulyawati, I. B., & Ramadhan, D. F. (2021). Bibliometric and visualized analysis of scientific publications on geotechnics fields. ASEAN Journal of Science and Engineering Education, 1(1), 37-46.

2. Durieux, V., & Gevenois, P. A. (2010). Bibliometric indicators: quality measurements of scientific publication. Radiology, 255(2), 342-351.

3. Liao, H., Tang, M., Luo, L., Li, C., Chiclana, F., & Zeng, X. J. (2018). A bibliometric analysis and visualization of medical big data research. Sustainability, 10(1), 166.

4. Van Eck, N. J., & Waltman, L. (2010). VOSViewer: visualizing scientific landscapes [Software]. Version, 1, 15.

5. Van Eck, N., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. scientometrics, 84(2), 523-538.