



Visual Analysis of Uterine Adhesion Research Based on CiteSpace: Bibliometric Analysis From 2006 to 2021

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Background: Intrauterine adhesion is caused by a variety of reasons, such as damage of the endometrial basal layer, adhesion or occlusion of the uterine cavity or cervix in different degrees. Seriously endangering women's physical and mental health.

Objective: The purpose of this paper is to analyze the research development of intrauterine adhesions in recent 15 years, explore the future development direction, and promote the development of this field.

Methods: With intrauterine adhesions and Ashman's syndrome as the theme, the related literatures from January 2006 to July 2021 in the Web of Science were searched, and the visual atlas was analyzed by CiteSpace software.

Results: A total of 644 literatures were included. The key words related to intrauterine adhesion mainly include adhesion, pregnancy, expression, intrauterine adhesions, women, adhesion molecule, diagnosis, activation, hysteroscopy and fertility, etc. Six clusters were obtained by keywords analysis, involving hysteroscopy, placenta, office hysteroscopy, uterus and laparoscopy. Co-occurrence of keywords shows that the research focus in recent years is on endometrial repair and regeneration.

Conclusions: Through the bibliometric analysis of WOS research on intrauterine adhesions in recent 15 years, the comprehensive analysis of countries, institutions, authors and keywords is obtained, which has a clear guiding significance for guiding the future development of intrauterine adhesions.

Keywords: intrauterine adhesion, Ashman's syndrome, CiteSpace, visualization analysis, knowledge mapping

INTRODUCTION

Intrauterine adhesion (IUA) was first proposed by Heinrich Fritsch in 1894 (1), and Joseph G Asher-Man published a series of papers in 1948 to name the disease and describing it in detail, so it is also called Asherman syndrome (2). IUA is a common intrauterine disease, referring to adhesion or even occlusion of uterine isthmus and cervical canal caused by various reasons (3–5). After the occurrence, it will cause serious harm to the reproductive function of patients (6, 7), and IUA patients may face serious obstetric complications (8), including placenta previa, placenta accreta and fetal growth restriction (9–12). In recent years, with the increasing number of intrauterine

operations such as induced abortion and curettage, the incidence of intrauterine adhesion has also shown an increasing trend year by year (13, 14). Because of the high incidence and recurrence rate of the disease, the disease is still difficult to treat at present (15). Hysteroscopic adhesiolysis is the most effective method to treat intrauterine adhesion, however the rate of re-adhesion formation after surgery is still high (16). At present, the conventional clinical treatment methods can't solve the serious intrauterine adhesion problem, which can only lead to limited effect and long treatment period (17).

It is essential to understand the research hotspots of intrauterine adhesion for studying effective treatment methods. Understanding the current research trends and hotspots will help medical workers keep up with the development and changes of professional research and provide reference for future professional research and high-quality practical work. Therefore, we use bibliometrics to help us understand the research focus and direction of intrauterine adhesion in the past 15 years.

Bibliometrics is a subject which uses mathematical and statistical methods to quantitatively analyze information (18, 19). It is a comprehensive knowledge system which integrates mathematics, statistics and philology that pays attention to

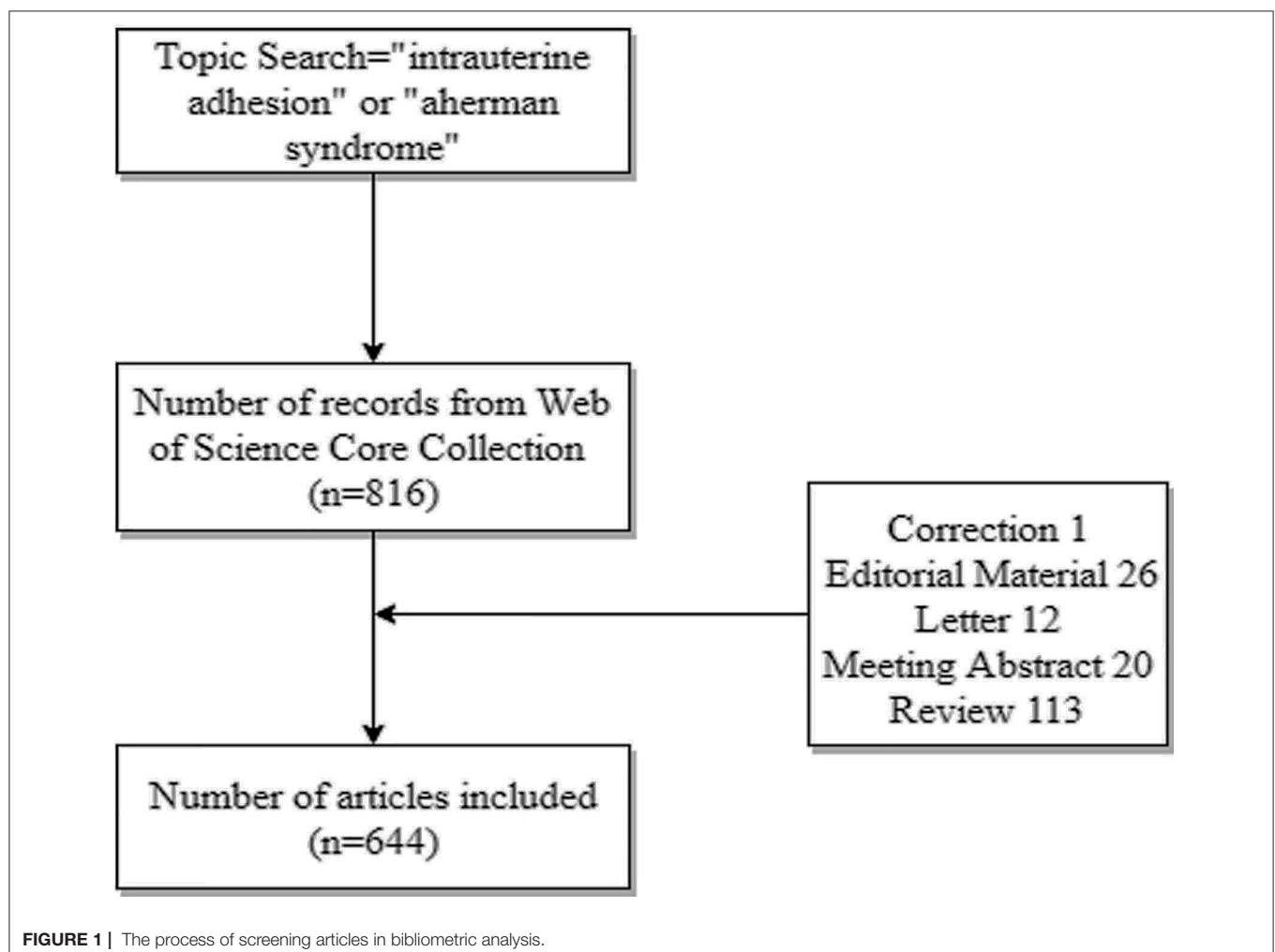
quantification (20, 21). It uses statistical indicators to measure the achievements in this research field (22, 23). It can not only qualitatively and quantitatively analyze the contributions and cooperation of authors, institutions, countries and journals (24, 25), but also make an in-depth assessment of the theme trends and focuses in a certain field (26, 27).

Although bibliometric analysis has been widely used in many disciplines, it is rarely used in the medical field, especially in obstetrics and gynecology. Up to now, there is no comprehensive study on intrauterine adhesions by bibliometrics. This paper aims to use CiteSpace, a free computer program, to analyze the current research progress and future development trend in the field of intrauterine adhesions in recent 15 years from a longitudinal perspective, to help medical workers accurately grasp the research trends and hot spots.

MATERIALS AND METHODS

Research Method

CiteSpace (version 5.7 R2) is a Java application that realizes the visualization of the retrieval bibliographic database (28). This



software can show the development trend and trend of a certain discipline or knowledge field in a certain period, and form the evolution process of several research frontier fields (29, 30). It is vividly presented in front of us in the form of a map (31, 32). Finally, it is analyzed and summarized manually to gain a general grasp of a certain research field.

Data Source and Retrieval Methods

We searched the Web of Science (WoS, <http://login.webofknowledge.com>) comprehensively (33). It is a large comprehensive, multidisciplinary and core journal citation index database (34), then this database has been used for bibliometric research before (35–37). Use topic search, and enter “intrauterine adhesion” or “aherman syndrome” in the search box. The search time is from January 1985 to July 2021. The literature sources are academic journals, and to avoid deviation caused by frequent database updates, all searches and data downloads were completed on July 21st, 2021, the results are exported in reworks format, a total of 816 records were retrieved.

Data Reduction

Using CiteSpace, 816 records were scientifically processed, and correction (1), editorial material (26), letter (12), meeting abstract (20) and review (113) were removed, and 644 valid documents were obtained, and the detailed information is shown in **Figure 1**. The time slicing area is set from 2006 to 2021 to deal with the literature from 2006 to 2021, and node type is checked one at a time, including author, institution, country, keyword.

RESULTS

Analysis of Published Articles

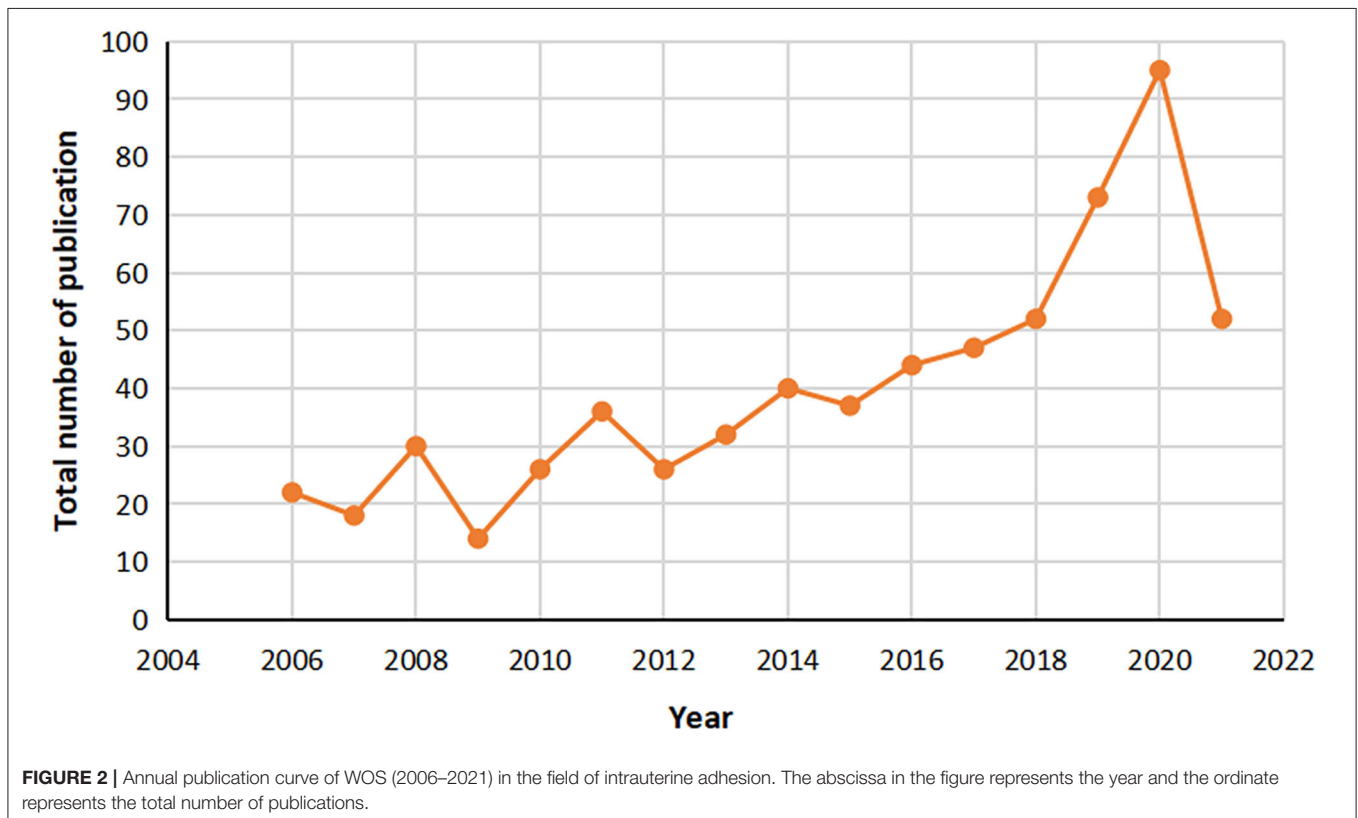
In the past 15 years from 2006 to 2020, the annual distribution of research papers related to intrauterine adhesion is shown in **Figure 2**. As can be seen from the figure, since 2006, the number of articles published has been increasing year by year, and the upward trend in 2020 is clearly higher than that in previous years.

Countries and Institutions Analysis

During this period, a total of 61 countries have published articles on this research field, and China (Circulation = 238) is the country with the largest contribution, followed by the United States (Circulation = 103), France (Circulation = 32), Britain (Circulation = 30) and Australia (Circulation = 23), in **Figures 3A,B** and **Table 1**. And from 2006 to 2021, more than 385 institutions published articles in this field. Capital Med Univ was the institution with the most publications (34), as shown in **Table 2**.

Authors Analysis

As shown in **Figure 3C** and **Table 3**, during the period from 2006 to 2021, more than 504 authors published articles, among which DABAO XU was considered the most active author in this field, with the largest number of articles (number = 10), XINGPING ZHAO the second



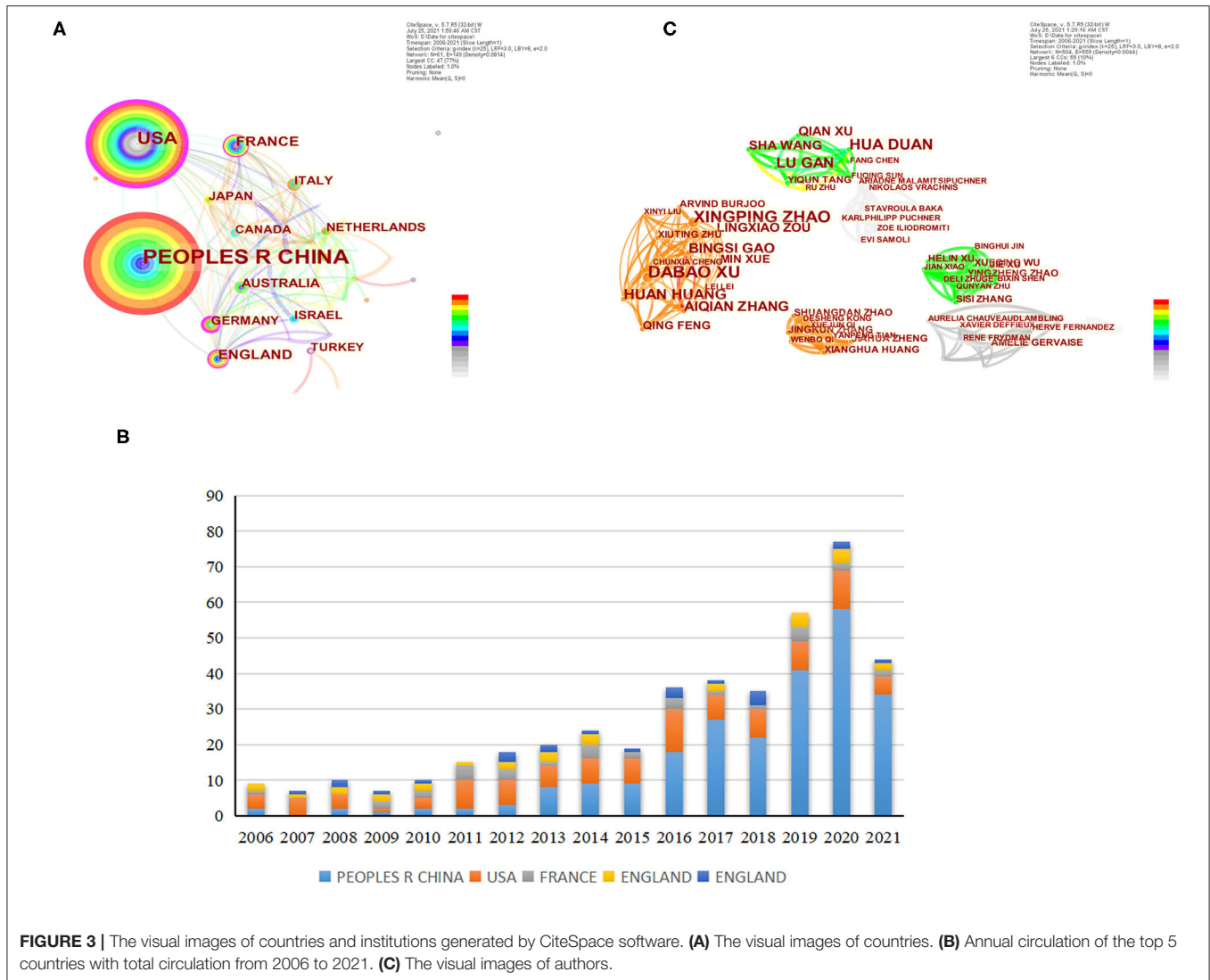


TABLE 1 | Top 10 countries by publishing frequency.

NO.	Countries	Year	Count	Centrality
1	Peoples R China	2006	238	0.00
2	Usa	2006	103	0.48
3	France	2006	32	0.18
4	England	2006	30	0.16
5	Australia	2007	23	0.04
6	Germany	2007	22	0.20
7	Netherlands	2007	21	0.04
8	Japan	2006	20	0.00
9	Israel	2006	19	0.01
10	Italy	2006	19	0.01

Year indicates the number of years in which articles were first published, and count indicates the number of articles published during this period.

TABLE 2 | Top 10 institutions by publishing frequency.

NO.	Institutions	Year	Count
1	Capital Med Univ	2012	34
2	Cent South Univ	2020	20
3	Zhejiang Univ	2016	15
4	Chinese Univ Hong Kong	2014	14
5	Southern Med Univ	2016	9
6	Chongqing Univ	2008	9
7	Chinese Acad Sci	2006	9
8	All India Inst Med Sci	2007	8
9	Tel Aviv Univ	2014	7
10	Fudan Univ	2014	7

Year indicates the number of years in which articles were first published, and count indicates the number of articles published during this period.

most (number = 9), HUA DUAN (number = 8), HUAN HUANG (number = 7), LU GAN (number = 7), and they are closely related.

Keyword Analysis

A total of 465 keywords were obtained from 614 literatures, and a co-occurrence map of keywords was drawn, as shown

in **Figure 4A**. Among them, the ten most frequently used keywords were intrauterine adhesions (frequency = 228), hysteroscopy (frequency = 109), women (frequency = 92),

management (frequency = 89), expression (frequency = 80), pregnancy (frequency = 75), ashermans syndrome (frequency = 72), infertility (frequency = 68), prevention (frequency = 55) and fertility (frequency = 52), in **Figure 4B**. And in **Table 4**, the most significant keywords were adhesion (centrality = 0.24), pregnancy (centrality = 0.20), expression (centrality = 0.13), intrauterine adhesions (centrality = 0.12), women (centrality = 0.10), adhesion molecule (centrality = 0.09), diagnosis (centrality = 0.08), activation(centrality = 0.08), hysteroscopy (centrality = 0.07) and fertility (centrality = 0.07). Then we obtained the largest 6 clusters as shown in **Figures 4C,D** and **Table 5**, and the modularity Q is 0.4518, the weighted mean silhouette S is 0.8038. Summarizing the main research directions of the six clusters, we found that most of them are treatments for intrauterine adhesions. After analyzing the keywords by timeline, it is found that new keywords appear almost every year. As shown in **Figure 5**, according to keyword burst analysis, during 2006–2021, there were 23 keywords to be found to have the strongest citation outbreak.

TABLE 3 | Top 10 authors by publishing frequency.

NO.	Authors	Year	Count
1	Dabao Xu	2015	10
2	Xingping Zhao	2020	9
3	Hua Duan	2016	8
4	Lu Gan	2016	7
5	Huan Huang	2020	7
6	Aiqian Zhang	2015	6
7	Songying Zhang	2018	6
8	Bingsi Gao	2020	6
9	Xiaona Lin	2018	6
10	Angelo B Hooker	2015	5

Year indicates the number of years in which articles were first published, and count indicates the number of articles published during this period.

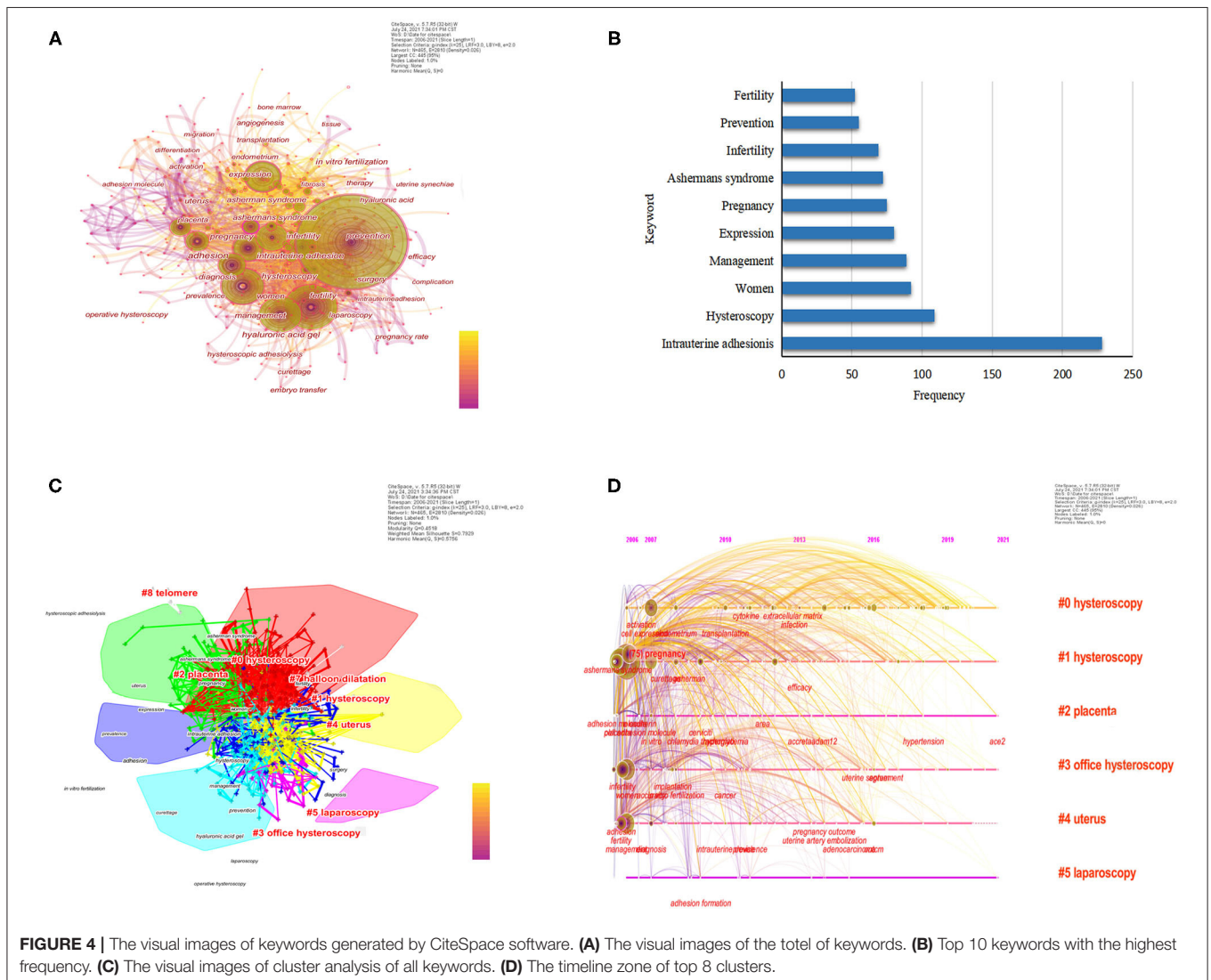


TABLE 4 | The top 10 keywords sorted by centrality.

NO.	Keywords	Centrality
1	Adhesion	0.24
2	Pregnancy	0.20
3	Expression	0.13
4	Intrauterine	0.12
5	adhesionis	0.10
6	Women	0.09
7	Adhesion molecule	0.08
8	Diagnosis	0.08
9	Activation	0.07
10	Hysteroscopy Fertility	0.07

TABLE 5 | The analysis of the top 6 clusters.

ClusterID	Size	Silhouette	Mean (Citee Year)	Label (LLR)
0	129	0.817	2016	Hysteroscopy
1	79	0.798	2012	Hysteroscopy
2	75	0.842	2008	Placenta
3	69	0.731	2011	Office hysteroscopy
4	63	0.773	2011	Uterus
5	22	0.867	2010	Laparoscopy

The cluster analysis results mainly include cluster ID, mean year, size, silhouette, label. Size expresses the number of keywords contained in the cluster, and Mean Year expresses the average year of documents in the cluster.

It can be observed that before 2014, the research hotspots of intrauterine adhesions mainly focused on the treatment of intrauterine adhesions, infertility and assisted reproductive technology, while in recent years, the hotspots focused on stem cell technology, endometrial repair and regeneration. Moreover, the concept of endometrial repair and regeneration which was proposed in 2018 has the highest citation rate, and is considered as the hottest and newest research direction in this field.

DISCUSSION

In this paper, CiteSpace was used to retrospectively analyze 644 papers on intrauterine adhesion since 2006, and the publication time distribution, cooperation network of the main authors, research hotspots and development trend of the papers in the field of intrauterine adhesion were intuitively reflected by the visual analysis of the knowledge map.

It can be seen from the publishing trend of the article that the published volume is steadily increasing year by year, this shows

that intrauterine adhesions are paid increasingly attention by medical workers, and China has made great contributions to the diagnosis and treatment of intrauterine adhesions. And through our analysis, we also find that not only the countries and regions involved in the research are relatively concentrated, but also the research institutions and researchers are relatively concentrated, and the centrality value is not very high.

According to the burst test of keywords, in recent years, we have paid increasingly attention to the repair and regeneration of endometrium, and stem cell therapy technology is also a hot research topic now. This will become the direction of our follow-up research. Based on the existing work, we will deeply explore the pathogenesis and diagnosis and treatment of intrauterine adhesions.

In summary, we have made a bibliometric analysis of the research hotspots and research reversals of intrauterine adhesions. Intrauterine adhesion has been paid close attention to by a wide range of medical workers, and increasingly clinical studies have promoted the diagnosis and treatment of intrauterine adhesion and the invention of new technologies. In the future, more multicenter in-depth research is needed to further provide evidence-based medicine research. This may have obvious guidance for the future work of researchers and medical workers. However, CiteSpace's analysis may be controversial and not deep enough. We will overcome these shortcomings by further evidence-based medicine analysis later.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: <http://login.webofknowledge.com>.

AUTHOR CONTRIBUTIONS

D-DD designing this study and writing initial draft and revision. D-DD and QZ reviewing the literature and analyzing. Z-XH making figures and tables. M-ZZ rechecking the manuscript and putting forward suggestions for amendment. QZ revising language and content. All authors contributed to the article and approved the submitted version.

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Top 23 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2006 - 2021
laparoscopy	2006	4.16	2006	2014	
intrauterine growth restriction	2006	3.88	2006	2012	
infertility	2006	5.68	2007	2011	
hysterosalpingography	2006	3.44	2007	2010	
transvaginal sonography	2006	3.27	2008	2011	
embryo transfer	2006	3.22	2008	2011	
curettage	2006	3.07	2008	2015	
adhesion molecule	2006	4.75	2010	2013	
uterus	2006	3.71	2011	2015	
intrauterine	2006	3.02	2011	2015	
hysteroscopy	2006	3.95	2014	2015	
injury	2006	3.45	2016	2019	
cell	2006	2.84	2016	2017	
stem cell	2006	3.71	2017	2018	
in vitro	2006	3.69	2017	2021	
regeneration	2006	5.07	2018	2021	
repair	2006	4.63	2018	2021	
fibrosis	2006	4.53	2018	2021	
proliferation	2006	4.43	2018	2021	
thin endometrium	2006	3.52	2018	2021	
mesenchymal stem cell	2006	4.42	2019	2021	
endometrial fibrosis	2006	3.74	2019	2021	
tgf beta	2006	3.64	2019	2021	

FIGURE 5 | Burst of keywords in CiteSpace. Red indicates the duration of a burst, indicating that keywords are frequently quoted, while green indicates keywords that are not frequently quoted.

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