



The 100 most-cited articles in thyroid surgery from 1990 to 2023: a bibliometric analysis

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Background: The 2015 U.S. guidelines for the diagnosis and treatment of thyroid nodules are recognized as authoritative in the industry, but lack a comprehensive assessment of the development of this field. The purpose of this bibliometric analysis is to identify and assess the 100 most-cited articles that have shaped the modern history of thyroid surgery.

Methods: The Web of Science Core Collection database was used to search the 100 most-cited articles in the field of thyroid surgery. VOSviewer was used to visually analyse countries/regions, institutions, authors, keywords, and characteristics of the top-100 articles.

Results: The citations of the 100 most-cited articles published between January 1990 and January 2023 ranged from 279 to 7,073. The 100 most-cited articles were published by 25 countries, over half of which were from the USA (n=54). Harvard University (14 articles) and University System of Ohio (14 articles) from the USA (The United States of America) were the top institutions. Schlumberger M from the Institute Gustave Roussy and University Paris Sud was the most productive author with 10 articles. The top-cited article was published by Haugen Bryan R *et al.* in *Thyroid* [2015] (citations =7,073). The keywords with the most co-occurrences were carcinoma, followed by fine-needle-aspiration, management, follow up, biopsy, radioactive iodine, and braf (v600e) mutation.

Conclusions: The top 100 articles in thyroid surgery have been cited widely and have had a profound impact. The USA was the most influential and productive country. Harvard University and University System of Ohio contributed most to the top 100 articles. Schlumberger M was the most productive and influential author. Moreover, especially thyroid papillary carcinoma, fine needle aspiration, is a research hotspot and potential direction in the future for thyroid surgery.

Keywords: Thyroid surgery; thyroid cancer; bibliometric analysis; citation; VOSviewer

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Introduction

With the rapid development of technology in the field of thyroid surgery, more thyroid diseases are gradually being identified, and surgeries for thyroid diseases have undergone substantial changes (1,2). For example, fine-needle aspiration (FNA) biopsy is widely used to confirm the diagnosis of thyroid cancer (3). In addition, nanocarbon and intraoperative nerve monitoring have improved thyroid surgical accuracy and perioperative results (4,5). Moreover, the adoption of innovative technology, such as cavity systems and robotic systems, has made minimally invasive surgical techniques possible and brought more options to thyroid surgery (6,7). The development of technology gradually promotes further in-depth research on the thyroid. At present, many high-quality and widely influential studies related to thyroid surgery have been published. Bibliometric analysis can serve to identify influential literature and rank the top 100 articles in order of impact by citation frequency (8). Bibliometric analysis can quantitatively analyse the impact of scientific research output in a certain field. There are many evaluation indicators for the influence of scientific research, and citation is one of the most commonly used indicators (9). The citation classics was introduced in 1955 by Eugene Garfield (10) to assess top-cited articles in the Web of Science (WoS) databases. Over the years, several surgical disciplines have used bibliometric analysis to identify the most influential papers in their respective fields, which

include obstetrics and gynecology (11), ophthalmology (12), gastroenterology, hepatology (13), otolaryngology (14), and urological emergencies (15). However, there is currently no visualization analysis related to thyroid surgery or diseases. The 100 most-cited articles on thyroid surgery are important resources for researchers to rapidly understand the knowledge system and development trend of the field. This objective literature review method may help promote future research and educational efforts (16). Thus, we performed a bibliometric citation analysis to identify the top 100 articles to intuitively and rapidly reveal the research hotspots and frontiers in the field of thyroid surgery. We believe that the present study will help researchers to form a comprehensive understanding of the subject of thyroid surgery.

Methods

Data source

The Science Citation Index Expanded (SCI-Expanded) database of Thomson Reuters WoS was used to identify the top 100 most frequently cited articles. The appropriate search terms were considered to ensure that all relevant manuscripts were identified, and the search strategy was as follows: [TS=(thyroid)] AND [TS=(surgery OR surgical OR operation OR operative)]. English-language articles published in all SCI-Expanded from January 1990 to January 2023 were included, and document types were limited to articles and reviews.

Statistical analysis

We ranked them by citations and selected the 100 most-cited articles. Each article was reviewed and basic information was collected by two researchers (D.L. and Y.H.), including article title, article type (article or review), source journal of the article, and year of publication. The co-occurrence of the keywords and cooperation network maps of institutions, authors, and countries were conducted by VOSviewer (Version 1.6.16).

Results

A total of 17,694 articles were searched in the period from January 1990 to January 2023. The 100 most-cited articles were published between 1990 and 2023 (*Figure 1*). The most common types of articles were consensus statements

Highlight box

Key findings

- This study provides practitioners with an authoritative hotspot map of the current academic development status in this field, providing data support for clinical practice optimization and scientific research resource allocation.

What is known and what is new?

- The 2015 guidelines for the diagnosis and treatment of thyroid nodules developed by the United States are recognized as authoritative in the industry.
- Reveal the three major focuses in this field: refinement of preoperative diagnosis, full-course management of differentiated thyroid cancer, and breakthroughs in molecular targeted therapy.

What is the implication, and what should change now?

- The guidelines should be strictly followed to further focus on molecular mechanisms and precise individualized medical strategies.

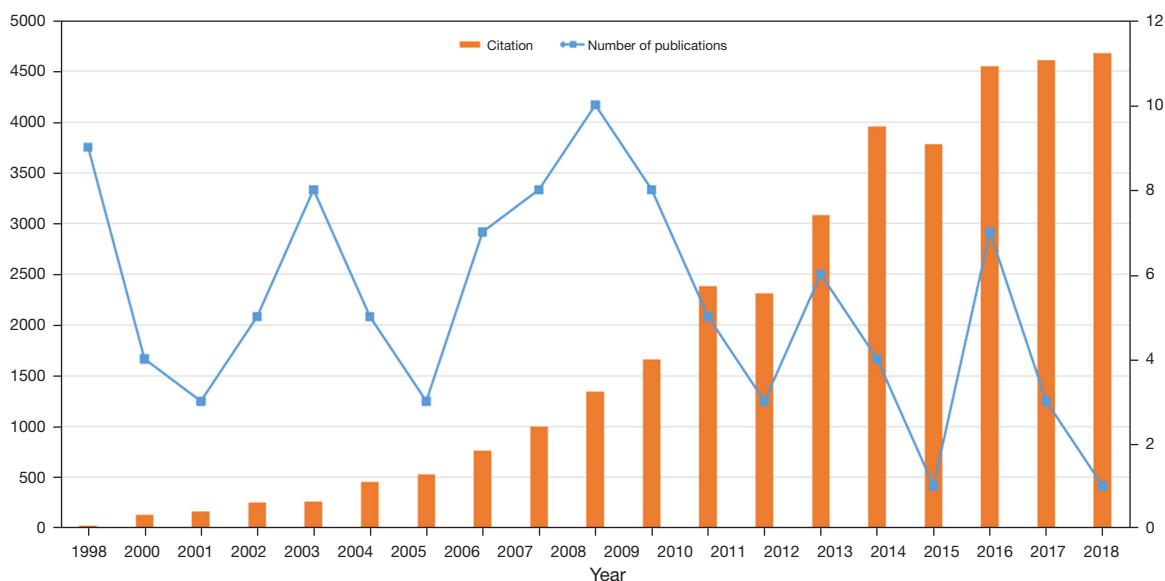


Figure 1 Distribution of citations by year of publication from 1990 to 2023.

and articles. There were 17 consensus guidelines, 16 cohort studies about the thyroid gland and 2 meta-analyses, 34 articles related to thyroid surgery and thyroid-associated endocrine tumors, 13 articles related to the diagnosis of thyroid nodules, and 5 articles related to postoperative complications in benign goiter surgery. The remaining 13 studies reported other studies related to thyroid surgery, such as the intraoperative location of parathyroid, American College of Radiology (ACR) thyroid imaging, reporting, and data system. [Table S1](#) lists the 100 top-cited articles as ranked by citations.

Publication and citation

The earliest one of the 100 top articles was published in 1998 in the journal *Cancer*, and Hundahl SA *et al.* proposed setting up The National Cancer Data Base (NCDB) as a tool to analyse care, evaluate tumor prognostic models, generate new hypotheses, and overcome related issues in this article (17). The most-cited article was published in 2015 in *Thyroid* by Haugen Bryan R *et al.*, it was cited as more as 7,073 times, with 884 mean citations per year since it was published (18). This article is a recognized guideline in the thyroid department, and as the incidence of thyroid nodules is gradually increasing (19), an increasing number of regions pay attention to this issue, resulting it have a high citation rate. The most recent three of the 100 top articles were published in 2017 and 2018. One reported

that dabrafenib and trametinib combination therapy in BRAF V600E-mutated anaplastic thyroid cancer was the first regimen and had robust clinical activity (20). One provided guidance regarding the management of thyroid nodules based on ultrasound appearance (21). The last one presented a standardized, category-based reporting system for thyroid FNA specimens (22).

Country analysis

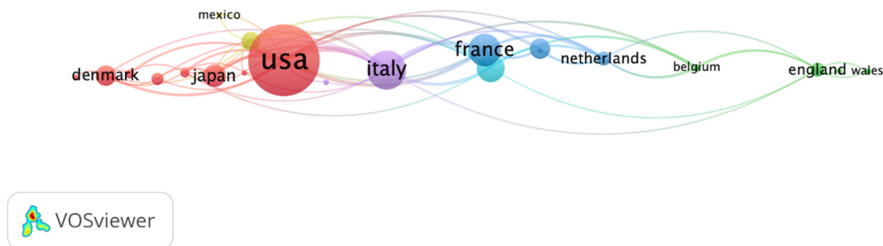
A total of 25 countries published the 100 top articles, and 13 countries had more than or equal to 2 articles. [Table 1](#) shows the top 10 countries with the most papers, and the top three countries were the USA [54], Italy [20], and France [15], which were the top 3 countries in terms of total citations and citation density. The top ten countries with the highest total citations in thyroid surgery research were all developed countries. [Figure 2](#) presents the collaboration of countries/territories, which shows that the top countries were the main cooperators with each other. Researchers in the USA collaborated with scientists in 14 countries/territories, including the Netherlands, Italy, France, and Japan.

Author analysis

A total of 694 authors around the world published the 100 top articles, and ten authors published more than 5 papers ([Table 2](#)). Professor Schlumberger M from the

Table 1 Major countries of origin for the top 100 articles in thyroid surgery

Rank	Country	Articles	Total citations	Average citation	Citation density	H-index
1	USA	54	39,648	734.2	33.0	91
2	Italy	20	22,542	1,127.1	19.8	30
3	France	15	19,045	1,269.7	16.1	35
4	Germany	12	5,992	499.3	4.0	32
5	Japan	8	3,656	457.0	2.5	35
6	Denmark	7	4,284	612.0	3.6	5
7	South Korea	7	3,080	440.0	2.1	20
8	Canada	6	9,712	1,618.7	11.6	32
9	England	4	1,607	401.8	1.5	36
10	The Netherlands	4	2,687	671.8	2.2	22

**Figure 2** Country cooperation graph of the top 100 most cited articles.

Institute Gustave Roussy and University Paris Sud ranked first with 10 articles and 16,439 citations. Furthermore, Schlumberger M participated as a committee member and drafted the American Thyroid Association management guidelines and differentiated thyroid carcinoma European consensus. Schlumberger M's research focuses on thyroid cancer, such as exploring radioiodine ablation in thyroid cancer and evaluating the prognosis of papillary thyroid cancer breaking through the capsule. In addition, professor Dralle H from Martin-Luther-University Halle-Wittenberg ranked second with 8 articles and a total of 4,166 citations. Notably, Professor Dralle H published the most articles as the first author and corresponding author. He led the research on recurrent laryngeal nerve monitoring and complications of thyroid surgery (23). Pacini F ranked third with 6 articles and a total of 14,938 citations. Mandel SJ has the highest average citations for research (2,715.8 citations). *Figure 3* presents the collaboration of the authors. The author groups centered on Schlumberger M, Nikiforov YE, and Steward DL constituted the largest cooperative

subnetwork.

Institutions analysis

Ten institutions were represented in more than 8 of the 100 top articles (*Table 3*). According to the number of articles, Harvard University and University System of Ohio led the list with 14 articles. Johns Hopkins University, Mayo Clinic, and University of Texas System ranked second with 13 articles. Gustave Roussy and Unicancer followed with 12 articles. In terms of average citations, the University of Pennsylvania (1,786.7 citations) ranked first, and Utm Anderson Cancer Center had 1,545.0 average citations following closely behind. *Figure 4* presents the collaboration of institutions, in which the Mayo Clinic in the USA collaborated widely with 31 institutions around the world. Important research partners of the Mayo Clinic included Johns Hopkins University, Gustave Roussy, and University of Pennsylvania. These partner institutions represent leading entities within the field in the United

Table 2 The most productive authors in top 100 articles

Rank	Author	Articles	Authorship				Affiliation	Country	Total citations	Average citation	Citation density	H-index
			First author	Corresponding author	Second/third author	Others						
1	Schlumberger M	10	2	3	2	3	Institute Gustave Roussy and University Paris Sud	France	16,439	1,643.9	14.7	99
2	Dralle H	8	2	4	2	0	Martin-Luther-University Halle-Wittenberg	Germany	4,166	520.8	2.3	74
3	Duh QY	6	0	0	2	4	Veterans Affairs Medical Center and University of California	USA	2,798	466.3	2.0	65
4	Kloos RT	6	1	1	0	4	The Ohio State University Comprehensive Cancer Center	USA	8,221	1,370.2	5.3	46
5	Nikiforov YE	6	3	1	0	2	University of Pittsburgh Medical Center	USA	9,344	1,557.3	10.6	67
6	Pacini F	6	2	1	0	3	The University of Siena	Italy	14,938	2,489.7	13.8	78
7	Steward DL	6	0	0	1	5	University of Cincinnati Medical Center	USA	14,079	2,346.5	13.7	46
8	Haugen BR	5	1	2	1	1	University of Colorado School of Medicine	USA	13,509	2,701.8	13.45	51
9	Machens A	5	2	1	2	0	Martin-Luther-University Halle-Wittenberg	Germany	1,704	340.8	0.8	44
10	Mandel SJ	5	0	0	0	5	Perelman School of Medicine	USA	13,579	2,715.8	13.4	43

States, demonstrating that high-caliber research frequently arises from collaborative efforts and technological exchange among diverse institutions. Consequently, it is imperative for practitioners to enhance inter-institutional cooperation in future endeavors.

Journal analysis

A total of 35 journals around the world published the 100 top articles. *Table 4* shows the top 10 journals that published the most articles among the 100 top articles.

Among them, three were specialized thyroid journals, three were specialized surgical journals, two were comprehensive cancer journals, and two were comprehensive medical journals. The top three journals were *Journal of Clinical Endocrinology Metabolism* with 16 articles, *Thyroid* with 13 articles, and *Cancer* with 10 articles. *Thyroid* had the highest total and average annual citations per article. The top 10 journals published 74% of the articles. The impact factor (IF) of the 10 journals varied between 3.28 and 202.72; five journals had an IF <5.00, two between 5.00 and 10.00, and three with an IF >10.00. *Lancet* had the highest

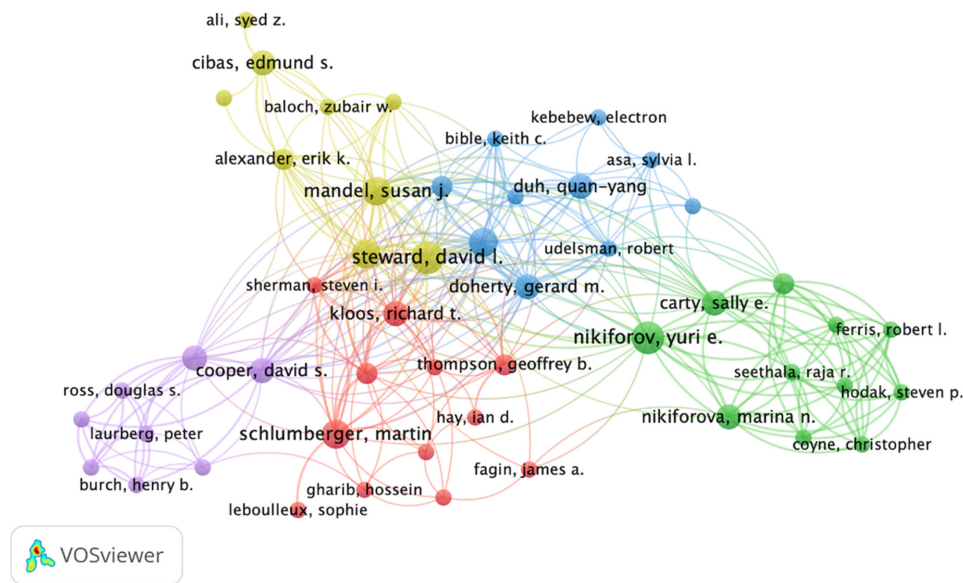


Figure 3 Author cooperation graph of the top 100 most cited articles.

Table 3 Top publishing institutions

Rank	Institution	Articles	Country	Total citations	Average citation	Citation density	H-index
1	Harvard University	14	USA	15,341	1,095.8	17.16	82
2	University System of Ohio	14	USA	18,705	1,336.1	16.46	70
3	Johns Hopkins University	13	USA	12,955	996.5	10.31	103
4	Mayo Clinic	13	USA	18,531	1,425.5	18.4	242
5	University of Texas System	13	USA	18,361	1,412.3	18.1	130
6	Gustave Roussy	12	France	17,989	1,499.1	15.7	25
7	Unicancer	12	France	17,989	1,499.1	15.7	5
8	Utmd Anderson Cancer Center	11	USA	16,994	1,545.0	16.5	3
9	Ohio State University	10	USA	10,200	1,020	6.6	83
0	University Of Pennsylvania	9	USA	16,080	1,786.7	16.0	130

IF (202.72), and the journal with the highest h-index was the *New England Journal of Medicine*. There were 7 journals in Q1, 2 in Q2, and 1 in Q3 in the Journal Citation Report (JCR) partitions, indicating that the quality of journals was generally quite good.

Keywords analysis

Figure 5 presents the co-occurrence keywords in the 100 most-cited articles. The most frequent keywords were

carcinoma (n=27), followed by management (n=26), cancer (n=24) fine needle aspiration (n=19), diagnosis (n=14), and surgery (n=11). Carcinoma was the keyword that appeared most frequently. “Management” ranked second, and was always accompanied by “cancer”, indicating that the importance of treatment guidelines, which is consistent with the high citation rate of consensus statements in 2015 in *Thyroid*. “Follow-up” had 8 occurrences and “quality of life” had 4 occurrences, indicating that patients required more improvement in their quality of life after thyroid surgery.

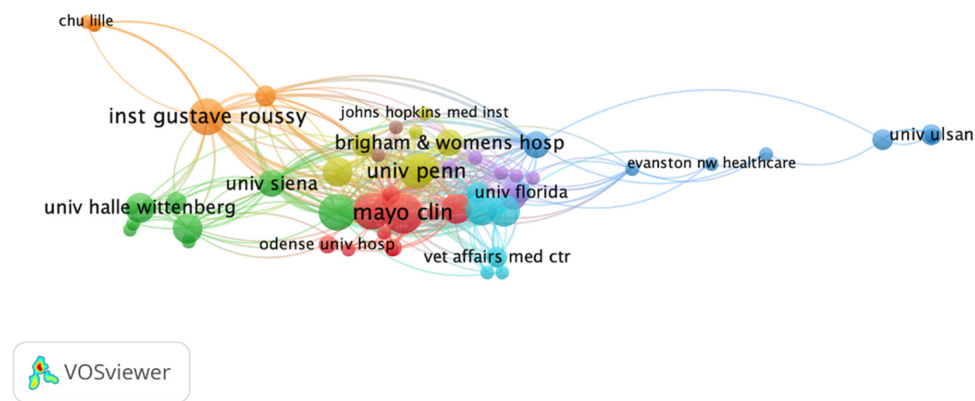


Figure 4 Institutional cooperation graph of the top 100 most cited articles.

Table 4 Journal distribution of top 100 articles in thyroid surgery

Rank	Journal	Articles	IF as of 2022	Total citations	Average citations/article	JCR	H-index
1	<i>Journal of Clinical Endocrinology Metabolism</i>	16	4.66	7,603	475.2	Q1	353
2	<i>Thyroid</i>	13	6.50	18,151	1,396.2	Q1	126
3	<i>Cancer</i>	10	6.92	4,854	485.4	Q1	277
4	<i>World Journal of Surgery</i>	8	3.28	3,226	403.2	Q2	135
5	<i>New England Journal of Medicine</i>	7	176.07	4,540	648.6	Q1	933
6	<i>Surgery</i>	7	4.34	2,395	342.1	Q1	148
7	<i>Annals of Surgery</i>	5	13.78	2,486	497.2	Q1	284
8	<i>Clinical Endocrinology</i>	3	3.52	1,413	471	Q3	137
9	<i>Lancet</i>	3	202.72	1,827	609	Q1	700
10	<i>Cancer Cytopathology</i>	2	4.35	945	472.5	Q2	45

IF, impact factor; JCR, Journal Citation Report.

A recent study suggests that early patient rehabilitation activities induce recovery of thyroid function and avoid the occurrence of nonthyroidal illness syndrome (24). Early functional exercise after thyroid surgery can effectively improve the quality of life of patients.

Discussion

The overall trend

With the growing development of thyroid surgery, an increasing number of new technologies and consensus have been proposed (18,25). Our study was the first bibliometric and visualized analysis of the top-100 most influential articles on thyroid surgery from 1990–2023. *Journal of*

Clinical Endocrinology Metabolism has 16 articles and ranks first among the top 100 articles. *Thyroid* had the most highly-cited papers and the most total citations. The most productive country was the USA. The Harvard University and University System of Ohio published the most highly-cited articles. Schlumberger M was the most influential author with 10 papers and 16,439 citations. Researchers and institutions from North America and Europe contributed the most. Moreover, there was extensive and close cooperation between the top countries, institutions, and authors.

Bibliometric studies can integrate information for scientific research and provide researchers with an intuitive perspective. IF, h-index, citation times, and average citation are the most common indexes used to assess the impact of research. Citation times and average citations are used to

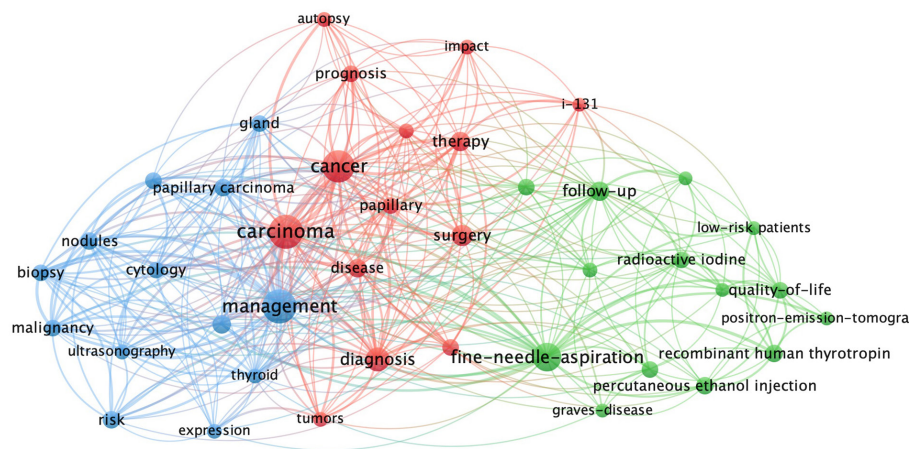


Figure 5 Keyword co-occurrence graph of the top 100 most cited articles.

reflect the impact of an article, institution, journal, author, and country (26). The USA was the dominant country for the most influential articles on thyroid surgery, with researchers and institutions contributing most to the 100 top articles. The USA published the highest number of papers, followed by Italy, France, Germany, and Japan. However, research productivity in the most influenced articles in Asian countries was relatively weak, with only two enrolled the top ten countries and none in the top 10 institutions or authors. We found that China only published one of the top 100 highly cited studies. Regarding cooperation, the USA, Italy, France, and Japan cooperated closely. The USA, as the center constituted the largest cooperative subnetwork. Asian countries should strengthen their in-depth cooperation with European and North American countries in this field.

The top 10 institutions that published these thyroid articles were located in the USA and France. The top authors are also mainly from those top institutions. This study also found that the number of authors was positively correlated with the number of institutions. There was close and broad cooperation among institutions such as Mayo Clinic, University of Texas System, and Johns Hopkins University. The top 100 journals mostly came from a high level that JCR was Q1. These top journals deserve more attention from thyroid researchers. Interestingly, the *New England Journal of Medicine* with high IF journals (2022 IF was 176.07) had fewer citations in the top 100 articles list, and it may be likely that higher citations of thyroid surgery papers are based on thyroid-specific journals, owing to the subspecialized topics.

Research progress on thyroid cancer and the significance of BRAF mutation

Among the top 10 scientists, 6 were from the USA. The support of science, policy, abundant finances, and the adoption of advanced devices might be the potential causes for the USA becoming the dominant country (27). Schlumberger M, Dralle H, and Nikiforov YE published the most articles as the first or corresponding author. Schlumberger M was the center for the author collaboration network. He often cooperated with Sophie Leboulleux, and they observed 148 consecutive papillary thyroid cancer patients with lymph node metastases and/or extrathyroidal tumor extension between 1987 and 1997, and concluded significant risk factors for disease, including the numbers of lymph node metastases and tumor size (21). This study helps to classify the risk of persistent and recurrent disease. Moreover, he collected clinical, biological, surgical, and epidemiological data on 899 medullary thyroid carcinoma patients between 1952 and 1996 to explore factors involved in the prognosis of medullary thyroid carcinoma (28). In addition, Hundahl SA, from the Queen's Medical Center in the USA, proposed a data to analyse care, evaluate tumor prognostic models and overcome related issues in 1998 (17). This study has great significance for describing thyroid tumors. In 1994, EL Mazzaferri *et al.* (29) followed-up 1,355 cases of papillary and follicular cancer over the past 40 years. The study found that the mortality of follicular and papillary cancers was similar after excluding patients with distant metastasis, and that near-total thyroidectomy with ^{131}I plus thyroid hormone had a better prognosis.

Cohort studies were the most common type of the top-100 highly-cited papers. The most frequently cited cohort study focused on the overall 10-year relative survival rate of all types of thyroid carcinoma (17), and Scott A Hundahl concluded that the 10-year overall relative survival rates of patients with papillary, follicular, Hürthle cell, medullary, and undifferentiated/anaplastic carcinoma were 93%, 85%, 76%, 75%, and 14%, respectively, in the USA. This conclusion defined thyroid-carcinoma relative survival. In 2005, Xing (30) observed BRAF mutations in 219 papillary cancer patients and found that BRAF mutation was an independent predictor of recurrence in papillary cancer patients, which helped establish risk stratification for papillary thyroid cancer patients. The results indicate that the study of papillary carcinoma has entered the molecular stage. With the deepening of research in recent years, research on thyroid cancer has rapidly developed.

Thyroid nodule guideline development

The highest frequency of occurrence keyword was “carcinoma”. It is closely related to “diagnosis”, “papillary carcinoma”, “management”, and “ultrasonography”. These keywords show accurate diagnosis and the whole process management of patients with thyroid papillary carcinoma is the focus of in-depth research in this field. Among thyroid cancers, papillary thyroid carcinoma has attracted more attention because it is the most common (31). Papillary thyroid carcinoma with inert tumor characteristics has received increasing attention in hospital follow-up. Ito found that more than 70% of the tumors had no significant change in size at the time of initial diagnosis after observing 162 patients with papillary cancer from 1993 to 2001 (32). Therefore, patients with papillary cancer who are unwilling to accept surgery should be closely followed-up. Antonelli *et al.* conducted a follow-up study involving 63 patients and determined that ultrasound monitoring was more effective than thyroglobulin measurement in detecting local tumors (33). Furthermore, ultrasound was superior in identifying the precise anatomical location of the tumors, a finding that was also applicable to pediatric studies (34). This viewpoint has been written into most national guidelines today and is constantly being improved. It can be confirmed that the diagnostic methods and patient management of papillary thyroid cancer were the focus of research in this field now and in the future. Thyroid cancer therapy (especially papillary carcinoma) and diagnosis of thyroid nodules

garnered the most academic attention in the 100 top-cited articles, which were the hottest research topics in the field of the thyroid.

Diagnosis of thyroid nodules and nerve monitoring development

With the development of diagnostic technology in recent decades, the accuracy of thyroid disease diagnosis has changed. In the top 100 studies, the diagnosis rate of newly diagnosed thyroid cancers <1 cm was 25% between 1988 and 1989, compared with 39% in 2008–2009 (18). The change in the incidence of thyroid cancer may be due to the increasing use of thyroid ultrasound, advances in ultrasound technology, the rapid development of thyroid imaging technology and early diagnosis and treatment (33). Professor H Gharib (34) reviewed the use of FNA biopsy in the diagnostic management of nodular thyroid disease from 1982 to 1991 in the journal *Annals of Internal Medicine*. This study noted that biopsy greatly improves the diagnostic accuracy of thyroid cancer and increases the choice of surgery. The most cited article was published in the journal of *Thyroid* by Haugen Bryan R *et al.* in 2015 and revised the standard ultrasound management guidelines for thyroid nodule FNA biopsy, unified thyroid imaging reporting and data system rules, as well as the management of thyroid and differentiated thyroid cancer. This study addressed key questions about thyroid cancer, including its definition, diagnosis, and optimal treatment (18). Intraoperative nerve detection during thyroid surgery serves as a crucial adjunct for identifying nerves within the thyroid gland, significantly contributing to the prevention of bilateral vocal cord paralysis. In 2010, Gregory W. Randolph and colleagues synthesized clinical experiences related to intraoperative nerve detection in thyroid surgery and conducted a comprehensive review of the pertinent literature. Their work harmonized the application and outcomes of nerve monitoring across various centers, thereby advancing its standardization. This publication is considered an essential reading within the field (35).

Limitations

There are a few limitations in this study. Firstly, the annual number of the 100 most cited articles in the field exploded from 2003 to 2016. The number of citations has been decreasing year by year since 2016. We consider that literature citations need to accumulate over time after the

article is published, and in fact, some recently published high-quality studies may not have received high citations yet, therefore, some recently published studies of possible high quality may be missed. Secondly, although we have tried our best to analyse the influence of the article from multiple perspectives, this study may favor articles that have been published for a longer time, and self-citations and incomplete citations also significantly contribute to citation rates. Moreover, we extracted SCI documents from the core collection database of the WOS and imposed a language restriction, which may have led to the exclusion of studies published in databases of other languages. Finally, this article was collaboratively authored by multiple contributors to ensure methodological consistency; however, the potential for selection bias remains (33).

Conclusions

This study identifies the 100 most cited articles in the field of thyroid surgery and provides insight into historical trends while providing guidance for future research. The USA was the most productive and influential country in terms of the number of top-cited articles. Professor Schlumberger M was the most prolific and influential researcher. The Harvard University and University System of Ohio published the most highly-cited articles. The *Journal of Clinical Endocrinology Metabolism* published the most top-cited 100 articles. Thyroid cancer has attracted the most academic attention in this field, especially papillary carcinoma. Keyword co-occurrence discovery showed that “fine needle aspiration”, “management” and “follow up” are worth paying attention to in this field.

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Footnote

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