



Bibliometric insights in advances of endoscopic thyroidectomy: research status, hotspots, and global trends

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Background: Endoscopic thyroidectomy (ET) has witnessed significant advancements over the last three decades. Various surgical methods and approaches have been developed that minimize trauma, enhance aesthetics, and reduce psychological stress caused by scars. Papillary thyroid carcinoma is the main reason for thyroidectomy and ET represents an innovative technique for treating thyroid cancer. In this study, nearly three decades of scientific articles were analyzed and summarized to gain a better understanding by using bibliometric method.

Methods: A total of 486 publications between 1996 and 2023 were retrieved from the Web of Science database through systematic searches. The objective of this study involved characterizing general information and investigating developmental trends and research frontiers. CiteSpace was employed to evaluate and visualize the results.

Results: The query resulted 486 publications with a total citation frequency of 10,202. The top five countries in terms of the number of published articles were China, South Korea, the USA, Italy, and Japan. The top five countries in terms of literature centrality were Scotland, Israel, Brazil, the USA, and France. There were eight institutions with more than ten publications. The top ten institutions had a centrality score of 0.02 or above, indicating intensive research in this area and substantial collaboration among institutions. The most cited authors primarily originated from South Korea. Journals such as *Surgical Endoscopy and Other Interventional Techniques*, *Surgical Laparoscopy Endoscopy & Percutaneous Techniques*, *Head and Neck Journal for the Sciences and Specialties of the Head and Neck*, and *Thyroid* exerted considerable influence in this field. Keyword analysis results revealed that research predominantly focused on thyroid cancer and surgical approaches.

Conclusions: This bibliometric study provides a comprehensive analysis of global productivity, collaboration, and research focus in the field of ET. The findings of this study serve as valuable guidance for future research in ET.

Keywords: Thyroid; endoscopic thyroidectomy (ET); thyroid cancer; surgery; bibliometrics

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Introduction

Thyroid cancer is the most prevalent endocrine tumor worldwide and the main reason for thyroidectomy (1). Surgery serves as a crucial treatment for thyroid tumors; however, conventional open thyroidectomy leaves a visible scar in the anterior neck region (2). With an increasing number of young women requiring treatment for thyroid carcinoma, patients are seeking treatment options offering both oncologic safety and favorable cosmetic outcomes. Consequently, thyroid surgeons should balance successful disease treatment with factors concerning the quality of life, such as minimizing postoperative scarring and offering patients cosmetic satisfaction (3). Since the advent of endoscopic thyroidectomy (ET) by Hüscher (4), various surgical methods and approaches have been developed that minimize trauma, enhance aesthetics, and reduce psychological stress caused by scars (5). Simultaneously, a growing body of literature has reported on the applicability of ET for treating thyroid cancer in low-risk patients (5).

Although numerous systematic reviews and meta-analyses have comprehensively and explicitly addressed ET research, only a few have summarized this topic from a bibliometric analysis perspective or provided insight into the developing trends in this domain. Furthermore, no studies have performed a bibliometric analysis of future trends for ET. Therefore, our aim was to conduct a bibliometric network analysis, offering an objective measurement of scientific literature and aggregating the perspectives of multiple

thyroid surgeons.

Given the absence of comparable bibliometric analyses in the research field of ET, we employed related tools to systematically and objectively evaluate the research foundation, frontiers, and focus of ET.

Methods

Data collection

The data were retrieved from the Web of Science (WoS) Core Collection database using an advanced search strategy on January 30, 2023. The key topic for retrieval was (Topics (TS) = (“thyroid cancer” OR “thyroid carcinoma”)) AND TS=(“endoscop*”). The refining method was (I) document type (article and review); (II) language (English). Subsequently, the final literature database set consisted of 484 retrieved publications, each containing the title, author, keywords, abstract, year, organization, citation, and other pertinent information. As the data were obtained from a publicly accessible database, no ethical permissions were necessary.

Data analysis

This study utilized CiteSpace 6.16R3 to conduct scientometric analysis, visualize collaboration networks (including authors, institutions, and countries), explore keyword co-occurrence, and analyze document co-citation clustering. The visualization of these collaborative networks within a specific discipline was based on the co-citation theory, which suggests that two documents have a co-citation correlation when they are cited together in another document.

Results

Publication year

WoS database search results retrieved 486 publications and reviews related to ET between January 1996 and January 2023. The annual publication count exhibited a consistent upward trend, suggesting a gradual increase in attention towards research on ET. Notably, the year 2022 witnessed the highest number of publications with 58 publications. In contrast, the years 1996 and 1999 recorded the lowest number of publications, each with only one publication (*Figure 1, Table 1*). These 486 literatures were cited 10,202 times in total, and each document was cited 20.99 times on

Highlight box

Key findings

- This is a visualization analysis of literature on the current research status, hotspots, and global trends of endoscopic thyroidectomy (ET), which has not been previously reported.

What is known and what is new?

- ET has been proposed for many years and offers unique advantages, particularly in terms of cosmetic outcomes. Over time, various surgical approaches have been developed to enhance the procedure's effectiveness and versatility.
- The development of ET varies across different countries, regions, and organizations, with varying degrees of advancement. The evolution of technology in this process of advancement and its future development trends are noteworthy.

What is the implication, and what should change now?

- ET, which ensures both cosmetic outcomes and safety, is the future development trend.

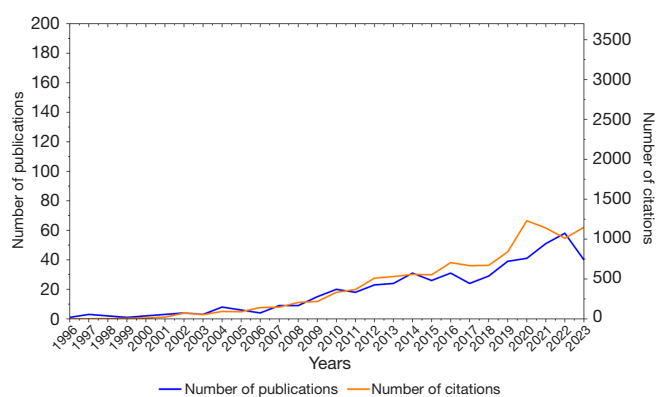


Figure 1 The annual trend of the frequency of citations and the number of papers published.

average; the h-index count was 49 (*Figure 1*).

Distribution of the countries and research institutions of the source of the literature

CiteSpace software was utilized to analyze the retrieved literature, generating country visualization maps (*Figure 2*) and institution visualization maps (*Figure 3*). The top five countries in terms of the number of publications were China, South Korea, the USA, Italy, and Japan. The top five countries in terms of literature centrality were Scotland, Israel, Brazil, the USA, and France (*Tables 2,3*). In *Figure 2*, the nodes representing countries were scarce, indicating that few countries were involved in this field. However, the leading countries exhibited numerous connections with other countries, suggesting that this field was focused in a few selected countries with extensive cooperation among them (*Figure 2*). There were eight institutions with more than ten publications. The top three institutions in terms of the number of publications were all located in Korea. The top five institutions in terms of centrality were Harvard Medical School, Seoul National University, Korea University, Sungkyunkwan University, and Yonsei University. All top ten institutions scored 0.02 or above for their centrality scores, indicating that research in this area was relatively intensive, with substantial cooperation among institutions (*Tables 4,5*).

Author distribution

As depicted in *Figure 4*, there were limited connections among authors, and the related literature published by each

Table 1 Annual distribution of the number of publications

Years	Number of records	Percentage of 486 (%)
1996	1	0.2
1997	3	0.6
1998	2	0.4
1999	1	0.2
2000	2	0.4
2001	3	0.6
2002	4	0.8
2003	3	0.6
2004	8	1.6
2005	6	1.2
2006	4	0.8
2007	9	1.9
2008	9	1.9
2009	15	3.1
2010	20	4.1
2011	18	3.7
2012	23	4.7
2013	24	4.9
2014	31	6.4
2015	26	5.3
2016	31	6.4
2017	24	4.9
2018	29	6.0
2019	39	8.0
2020	41	8.4
2021	51	10.5
2022	58	11.9
2023	1	0.2

author was relatively scarce. The top five authors in terms of the number of publications were Dionigi, Gianlorenzo; Kim, Hoon Yub; Chung, Woong Youn; Tufano, Ralph P; and Kang, Sang-Wook (*Table 6*). Only seven authors had a centrality score reaching 0.01 (*Table 7*), indicating limited collaboration among authors. Concerning literature citations, the most frequently cited authors primarily hailed from Japan (Ikedy Y), Italy (Miccoli P), and South Korea

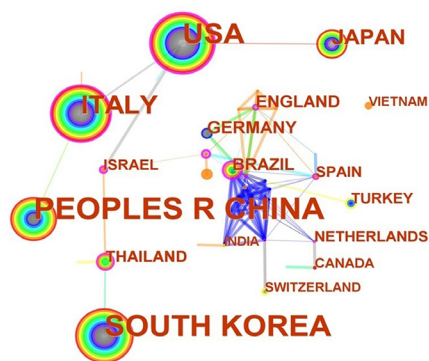


Figure 2 Country visualization map the co-operation in researches.



Figure 3 Institution visualization map showed the co-operation in researches. Univ, University; Hosp, Hospital; Med, Medicine; Clin, Clinic; Med Univ, Medical University; Canc Ctr, Cancer center; Natl Univ, National University; Natl Univ Hosp, National Universal Hospital.

Table 2 Top 10 countries in terms of number of publications

Rank	Countries	Publications (n)
1	China	142
2	South Korea	118
3	USA	97
4	Italy	62
5	Japan	27
6	Germany	13
7	Brazil	12
8	England	12
9	Thailand	10
10	Israel	8

Table 3 Top 10 countries for centrality

Rank	Countries	Centrality score
1	Scotland	0.65
2	Israel	0.59
3	Brazil	0.41
4	USA	0.36
5	France	0.23
6	Spain	0.19
7	England	0.18
8	The Netherlands	0.16
9	Italy	0.15
10	Thailand	0.15

Table 4 Top 10 institutions in terms of number of publications

Rank	Institution	Publications (n)	Country
1	Seoul National University	24	South Korea
2	Yonsei University	23	South Korea
3	Korea University	18	South Korea
4	Zhejiang University	16	China
5	Johns Hopkins University	15	USA
6	The Catholic University of Korea	13	South Korea
7	University of Messina	12	Italy
8	Cleveland Clinic	10	USA
9	Sungkyunkwan University	9	South Korea
10	Hanyang University	8	South Korea

Table 5 Top 10 research institutions in terms of centrality

Rank	Institution	Centrality score	Country
1	Harvard Medical School	0.08	USA
2	Seoul National University	0.07	South Korea
3	Korea University	0.06	South Korea
4	Sungkyunkwan University	0.06	South Korea
5	Yonsei University	0.05	South Korea
6	Cleveland Clinic	0.05	USA
7	Johns Hopkins University	0.02	USA
8	Catholic University of Korea	0.02	South Korea
9	Police Gen Hospital	0.02	Thailand
10	Centro de Investigacion Biomedica en Red de Cancer	0.02	Spain

**Figure 4** Co-author visualization map showed that the co-operation in researches.

Table 6 Top 10 authors by number of literatures published

Rank	Author	Publications (n)	Country
1	Dionigi, Gianlorenzo	18	Italy
2	Kim, Hoon Yub	16	South Korea
3	Chung, Woong Youn	16	South Korea
4	Tufano, Ralph P	12	USA
5	Kang, Sang-Wook	11	South Korea
6	Chai, Young Jun	9	South Korea
7	Nam, Kee-Hyun	9	South Korea
8	Jeong, Jong Ju	8	South Korea
9	Choi, Eun Chang	8	South Korea
10	Youn, Yeo-Kyu	8	South Korea

Table 7 Top seven authors for centrality

Rank	Author	Centrality score	Country
1	Chai, Young Jun	0.02	South Korea
2	Choi, June Young	0.02	South Korea
3	Dionigi, Gianlorenzo	0.01	Italy
4	Kim, Hoon Yub	0.01	South Korea
5	Tufano, Ralph P	0.01	USA
6	Choe, Jun-Ho	0.01	South Korea
7	Berber, Eren	0.01	USA

(Kang SW). Korean authors published the most articles and were cited relatively often (*Figure 5; Tables 8,9*).

Distribution of journals

The 486 articles in the present study were from 200 journals, of which seven journals published more than 10 articles (*Table 10*). The articles published in these seven journals account for 30.7% of the total number of articles included in this study (*Table 9*). According to the results shown in the *Tables 10-12* and *Figure 6*, it is inferred that journals such as *Surgical Endoscopy and Other Interventional Techniques*, *Surgical Laparoscopy Endoscopy & Percutaneous Techniques*, *Head and Neck Journal for the Sciences and Specialties of the Head and Neck* and *Thyroid* have greater influence in this field.

Keyword analysis

CiteSpace software was used to construct a keyword cooccurrence map (*Figure 7*). The top ten keywords in frequency and centrality are listed in *Tables 13,14*. In addition to surgery, thyroid cancer, cancer and carcinoma, high-frequency keywords were papillary thyroid carcinoma, management, experience, robotic thyroidectomy and video assisted thyroidectomy. The centrality results suggest that ET research focuses on selection of surgical methods and diagnosis (*Table 14*). For keywords with high frequency of use, CiteSpace was used for burst detection. The results are shown in *Figure 8*. It can be seen that the high-frequency keywords have gradually evolved from the initial “endoscopic ultrasonography”, “medullary thyroid carcinoma” and “lobectomy” to the current “transoral

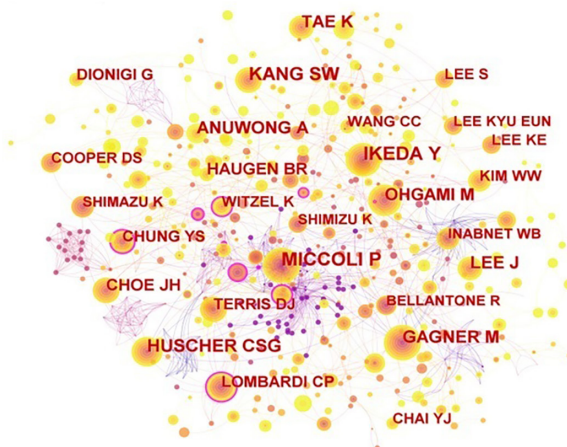


Figure 5 Author co-cited visualization map showed authors been cited in literatures.

Table 8 Top 10 most cited authors by the number of citations

Rank	Author	Frequency (n)	Country
1	Ikedy, Y	126	Japan
2	Miccoli, P	123	Italy
3	Kang, SW	119	South Korea
4	Huscher, CSG	96	Italy
5	Gagner, M	88	Canada
6	Lee, J	87	South Korea
7	Anuwong, A	84	Italy
8	Tae K	76	South Korea
9	Ohgami, M	76	Japan
10	Haugen, BR	62	USA

Table 9 Top 10 centrally cited authors

Rank	Author	Centrality score	Country
1	Antonelli, A	0.32	Sweden
2	Adams, S	0.23	Australia
3	Ballantyne, GH	0.18	USA
4	Roh, JL	0.17	South Korea
5	Chung, YS	0.15	South Korea
6	Shaha, AR	0.15	USA
7	Ahlman, H	0.13	Sweden
8	Lombardi, CP	0.12	Italy
9	Witzel, K	0.12	Germany
10	Ito, Y	0.12	Japan

Table 10 Top 20 journals by number of articles published

Rank	Journals	Number of records	Percentage of 486 (%)
1	<i>Surgical Endoscopy and Other Interventional Techniques</i>	47	9.67
2	<i>Surgical Laparoscopy Endoscopy & Percutaneous Techniques</i>	28	5.76
3	<i>Head and Neck Journal for the Sciences and Specialties of the Head and Neck</i>	19	3.91
4	<i>Gland Surgery</i>	15	3.09
5	<i>Thyroid</i>	14	2.88
6	<i>Journal of Laparoendoscopic Advanced Surgical Techniques</i>	13	2.67
7	<i>World Journal of Surgery</i>	13	2.67
8	<i>Frontiers in Surgery</i>	9	1.85
9	<i>Frontiers in Oncology</i>	8	1.65
10	<i>Laryngoscope</i>	8	1.65
11	<i>Annals of Surgical Oncology</i>	7	1.44
12	<i>BMC Surgery</i>	7	1.44
13	<i>Surgery</i>	7	1.44
14	<i>Frontiers in Endocrinology</i>	6	1.23
15	<i>World Journal of Surgical Oncology</i>	6	1.23
16	<i>Acta Otorhinolaryngologica Italica</i>	5	1.03
17	<i>Annals of Otology Rhinology and Laryngology</i>	5	1.03
18	<i>Annals of Surgical Treatment and Research</i>	5	1.03
19	<i>Cancer Management and Research</i>	5	1.03
20	<i>Indian Journal of Surgery</i>	5	1.03

Table 11 Top 10 journals by citation

Rank	Journals	Frequency (n)
1	<i>World Journal of Surgery</i>	297
2	<i>Surgical Endoscopy and Other Interventional Techniques</i>	273
3	<i>Thyroid</i>	264
4	<i>Surgery</i>	261
5	<i>Head and Neck Journal for the Sciences and Specialties of the Head and Neck</i>	210
6	<i>Surgical Laparoscopy Endoscopy & Percutaneous Techniques</i>	194
7	<i>Laryngoscope</i>	169
8	<i>Annals of Surgical Oncology</i>	156
9	<i>Journal of the American College of Surgeons</i>	143
10	<i>Journal of Clinical Endocrinology & Metabolism</i>	129

Table 12 Top 10 journals by centrality score

Rank	Journals	Centrality score
1	<i>American Journal of Medicine</i>	0.21
2	<i>American Journal of Clinical Pathology</i>	0.17
3	<i>Anticancer Research</i>	0.13
4	<i>Annals of Thoracic Surgery</i>	0.12
5	<i>Cancer</i>	0.11
6	<i>American Journal of Gastroenterology</i>	0.11
7	<i>Annals of Internal Medicine</i>	0.1
8	<i>British Journal of Cancer</i>	0.09
9	<i>Archives of Internal Medicine</i>	0.09
10	<i>Clinical Endocrinology</i>	0.08

thyroidectomy”, “vestibular approach” and “papillary thyroid cancer”.

Discussion

ET is a novel technique with a limited but growing number of publications. The increasing trend in the literature indicates that many scholars consider this field worthy of in-depth and extensive research. This is not only due to the demonstrated safety and efficacy of ET in low-risk patients (3,5-8), but also its consideration of wound aesthetics and the provision of favorable cosmetic and reduce psychological stress caused by scars. Asian countries, particularly South Korea, have published a larger number of relevant publications, as they place significant emphasis on aesthetic appeal, which has contributed to the development of ET in

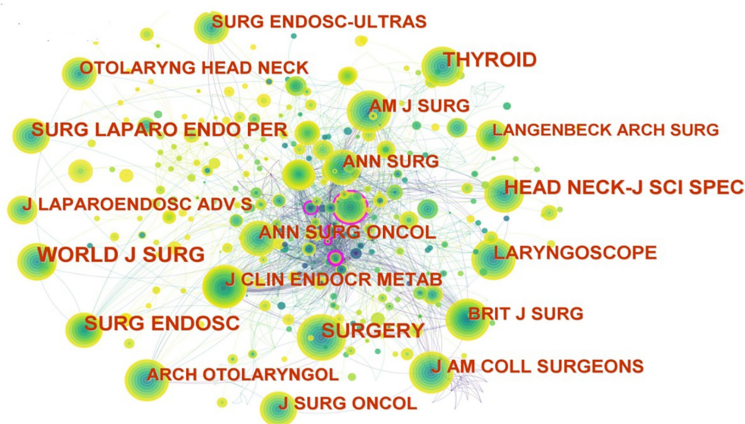


Figure 6 Journals co-cited visualization map showed journals been cited in literatures.

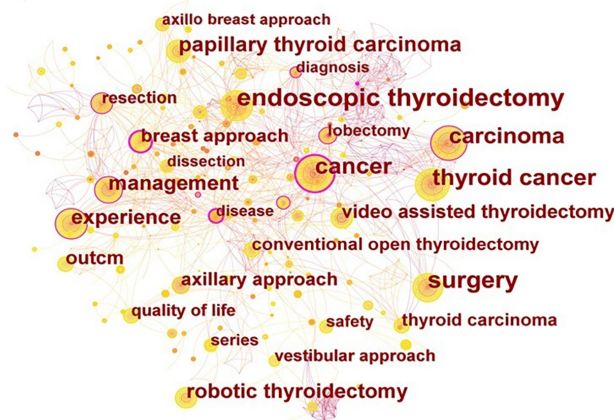


Figure 7 Keyword co-occurrence map showed that the most used keywords and the relationship between keywords.

Table 13 Top 10 frequently used keywords

Rank	Keywords	Frequency (n)
1	Endoscopic thyroidectomy	166
2	Surgery	135
3	Thyroid cancer	111
4	Cancer	110
5	Carcinoma	96
6	Papillary thyroid carcinoma	65
7	Management	63
8	Experience	60
9	Robotic thyroidectomy	59
10	Video assisted thyroidectomy	44

Table 14 Top 10 keywords for centrality

Rank	Keywords	Centrality score
1	Breast approach	0.29
2	Cancer	0.26
3	Disease	0.23
4	Endoscopic ultrasonography	0.22
5	Lobectomy	0.19
6	Diagnosis	0.17
7	Resection	0.15
8	Carcinoma	0.14
9	Central neck dissection	0.12
10	Fine needle aspiration	0.12

the region. However, countries with higher centrality in this field are predominantly not Asian nations, such as Scotland, Israel, Brazil, and the USA. Our findings also reveal that the number of relevant publications in this field by major researchers is relatively small, with Gianlorenzo Dionigi from Italy, who primarily focuses on transoral robotic thyroidectomy (9-11), have only published 18 articles on ET. This suggests that there is less research in this field compared to others. The most frequently published and cited papers are in surgical journals, such as *Surgical Endoscopy and Other Interventional Techniques*, and *Surgical Laparoscopy Endoscopy & Percutaneous Techniques*, indicating that the relevant literature in these journals merits further attention. Keyword analysis results reveal that high-

frequency keywords have shifted, and the focus has evolved from initial terms such as “endoscopic ultrasonography”, “medullary thyroid carcinoma”, and “lobectomy” to current terms like “transoral thyroidectomy”, “vestibular approach”, and “papillary thyroid cancer”. This change suggests that transoral and trans-axillary approaches for treating papillary thyroid carcinoma are well-developed, especially in Asia. The findings of this study indicate that ET research has made significant advancements over the past two decades; however, further investigation is still necessary. Future research directions may include enhancing surgical instruments, such as devising solutions for the smoke issue during transoral ET. Additionally, exploring more diverse surgical pathways to cater to patients’ varying needs and investigating strategies to minimize the risk of complications during surgery, particularly concerning recurrent laryngeal nerve injury, could offer promising avenues for further research.

Thyroid disease frequently affects young women, and its incidence among this demographic is on the rise (9,12). In addition to seeking effective treatment for the disease, patients are increasingly concerned about their postoperative quality of life, particularly regarding the extent of surgical scarring. Consequently, there has been a growing interest in the cosmetic outcomes and minimally invasive nature of thyroid surgery, which has led to the development of endoscopic surgical techniques.

ET is considered suitable for patients with benign thyroid disease or patients with low-risk papillary thyroid carcinoma. Generally, indications for ET encompass benign thyroid conditions, papillary microcarcinomas, and thyroid tumors smaller than 6 cm in size (13-16). Numerous studies have demonstrated no significant differences in safety and prognosis between traditional open thyroid surgery and ET (10,14-16). Common complications of ET include transient/permanent hypocalcemia and transient/permanent recurrent laryngeal nerve palsy, with the incidence of transient/permanent recurrent laryngeal nerve palsy ranging from 0–6% and less than 1% (17). Operative time is considerably shorter for open thyroidectomy compared to ET. However, surgeons can significantly reduce operating time through extensive experience and the use of advanced instruments such as the harmonic scalpel, nerve detector, and nano-carbon, which is utilized for tracing lymphoid tissue during thyroid cancer surgery (18,19).

The primary surgical approaches include minimally invasive video-assisted thyroidectomy (MIVAT), endoscopic thyroidectomy via the anterior chest approach (ETACA),

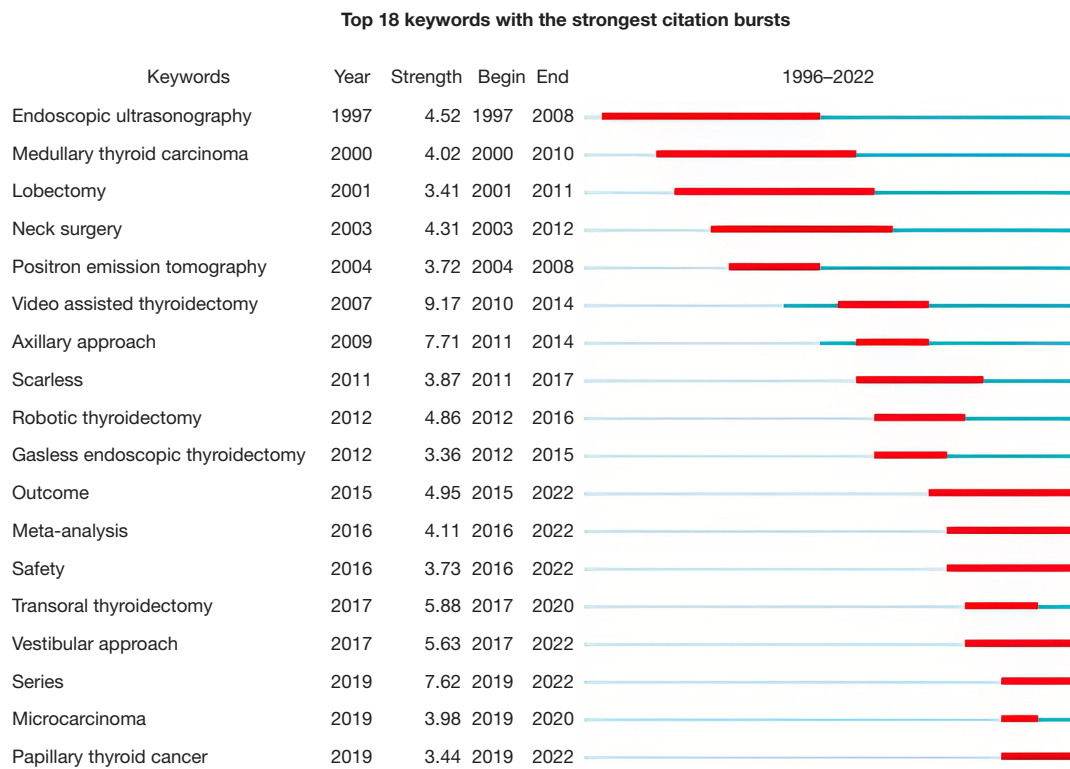


Figure 8 Burst analysis showed that the utility of key words changed annually.

the transoral endoscopic thyroidectomy vestibular approach (TOETVA), the endoscopic thyroidectomy via trans-axillary approach (ETTA) and robot-assisted ET. Each approach presents its own advantages and disadvantages.

MIVAT is no longer considered a standard procedure for two main reasons: first, it is unsuitable for treating malignant tumors, and second, approximately 1–5% of patients require conversion to open surgery during the procedure (20). Nevertheless, except for the oral approach, no other methods can avoid cutaneous scarring in the head, neck, or chest region (21). Extra-cervical approaches also necessitate more extensive flap dissection, tissue disruption, and prolonged operative times. The compatibility of these shortcomings with minimally invasive principles remains a subject of debate (22).

Regarding the TOETVA, recent advancements have led to its successful refinement and application in the transoral endoscopic parathyroidectomy vestibular approach, yielding few complications and excellent results (23,24). However, the wound associated with TOETVA is categorized as a clean-contaminated wound, potentially presenting a higher risk of infection (25). Simultaneously, the operative time

and learning curve are longer compared to traditional open surgery.

ETACA is currently the most common surgical approach, which not only treats the disease but also focuses on cosmetic outcomes. The trans-areolar approach, in particular, offers excellent cosmetic results. ETACA leaves no visible scar on the neck, and the small incision scar on the chest is easily concealed. It allows for total thyroidectomy and the surgical perspective is similar to traditional open surgery, making it easier for beginners to learn. However, due to anatomical limitations, there is a natural blind spot in the suprasternal area, which may result in incomplete clearance of central compartment lymph nodes (26).

ETTA offers natural advantages in the mobilization and protection of the recurrent laryngeal nerve due to its lateral approach. It does not require gas insufflation, resulting in fewer postoperative complications compared to procedures that require gas insufflation. Additionally, ETTA has a shorter learning curve and is easily adaptable, making it the fastest-growing surgical approach currently. However, performing total thyroidectomy using this technique is

impossible (18).

Robot-assisted thyroidectomy expands the range of surgical options for thyroid conditions, encompassing total thyroidectomy, lymph node dissection, and lateral region dissection. Nevertheless, it poses a high risk of transient postoperative hypocalcemia and incurs considerable expense (27,28). Although remote thyroidectomy techniques have been developed, their adoption in clinical practice remains limited (29,30).

The surgical approaches for robotic thyroidectomy primarily include three types: transaxillary, transoral and retro auricular. The advantages and disadvantages of the first two approaches are similar to those of traditional endoscopic surgery. Although the retro auricular approach can reduce the risk of injury to blood vessels, esophagus, and anterior chest nerves, there is a possibility of damaging the greater auricular and marginal mandibular nerves. Additionally, the incision is more visible compared to the other two approaches, which is why it is currently less commonly used (31).

After conducting a comprehensive literature review, including highly cited works, we have identified significant research within this field. However, our study is not without limitations. Despite the overall upward trend in publications, fluctuations are present, indicating inconsistencies in research in this area. Our search strategy, which utilized “endoscop*” in conjunction with (“thyroid cancer” and “thyroid carcinoma”), may have excluded some relevant documents. To accurately represent the current state of research in this field, future studies should refine the search strategy, eliminate duplicate publications, and minimize omissions.

Conclusions

In this study, we presented a scientometric evaluation of the retrieved publications on ET. It reveals that ET is undoubtedly a major emerging trend in the future development of the thyroid field particular in micropapillary thyroid cancer. Considering the increasing incidence of thyroid tumors and the fact that many patients are female with cosmetic concerns, further research on ET would be beneficial for the development of the thyroid field.

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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