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Evolution of the Percutaneous Nephrolithotomy: A Holistic Investigation of Global Outputs with Bibliometric Analysis

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What's known on the subject? and What does the study add?

Percutaneous nephrolithotomy (PCNL) is important because it involves invasive procedures for the treatment of large and complex nephrolithiasis. Nowadays, as the number of PCNL operations increases, clinicians are focused on increasing the success rate of surgical treatments and reducing complication rates. Bibliometrics is a statistical method used to analyze scientific research. It enables us to analyze the most cited studies and trending issues in a specific subject, as well as explore new ideas by examining new trends from the past to the present. Over time, we have observed an increase in the number of papers related to PCNL in our analyses. Incidentally, we have noticed that these studies primarily focus on the success and reliability of PCNL. In this context, we have observed a significant increase in research on surgical approaches, such as the use of the Guy's scoring system to select appropriate patients pre-operatively, mini PCNL, and the prone position.

Abstract

Objective: This bibliometric study identifies the studies, institutions and journals with the highest impact by analyzing the articles published about percutaneous nephrolithotomy (PCNL) and further to establish trend topics and to holistically summarize and interpret collaboration among countries.

Materials and Methods: Studies published about PCNL between 1975-2020 were downloaded from the Web of Science (WoS) database. They were analyzed using bibliometric and statistical methods. Spearman's correlation coefficient was used for correlation analysis. Non-linear regression analysis was used to estimate the number of publications in the coming years.

Results: A total of 4170 publications were found and 1936 (46.4%) of these publications were articles. We observed that the articles on PCNL have gradually increased in an exponential trend. Top 5 countries having contributed most to the literature ranked as Turkiye (n=376), USA (n=332), China (n=323), India (n=210) and Iran (n=123). Top 3 most active institutions were ranked as Guangzhou Medical University (n=63), University of Health Sciences Turkiye, İstanbul Haseki Training and Research Hospital (n=52) and Başkent University (n=32).

Conclusion: In our study, we observed that there has been an increase in the number of PCNL-related publications over the course of time. Besides, we determined that recent publications, mainly focused on the success and reliability of PCNL. In this context, there has been a steady increase in the number of studies on the use of Guy's scoring system for preoperative selection of eligible patients and surgical approaches such as mini PCNL, prone position.

Keywords: Percutaneous nephrolithotomy, trend topics, bibliometric analysis

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Introduction

Urinary stone diseases date back to 4000 B.C. and have played a crucial role in the practice of urology. There has been a significant increase in its prevalence in particular given the changing lifestyles of the societies during time. urolithiasis affects almost 12% of the world population (1). In parallel to the technological advancements in the field of medicine, the main approaches used for treating urolithiasis are the minimally invasive methods. Among these methods, percutaneous nephrolithotomy (PCNL) plays a major role (2). This treatment modality, firstly described in 1976 by Fernström and Johansson, has started to be used in a wide geography in particular as from the beginning of the 20th century for the treatment of urinary stone diseases, mainly complex renal stones (3). Today, it is intensely focused on increasing the success rate of PCNL and obtaining lower complication rates. In this respect, several different strategies have been developed, mainly to produce more minimal surgical equipment and to make modifications in the surgical techniques (4).

Bibliometrics is the use of statistical methods to analyze scientific research as mainly the articles (5). It has been observed that there is an increasing interest in studies based on bibliometric analyses in parallel to the increasing number of publications in the literature, particularly in the recent years on major topics in the field of medicine (6). Bibliometric analyses allow researchers to identify the most cited studies on a certain topic; most researched trend topics; the impact of the countries, institutions, journals and authors and international collaborations (5,6). Besides, this type of article, which provides a summary of the literature, also enables researchers to explore new ideas by analyzing the past and present trends (5).

An evolving interest in global medical research is emerging. Nevertheless, there is still no bibliometric study in the literature on PCNL, which is a minimally invasive approach used widely for treating urinary stone diseases, despite the changing surgical techniques and advances in surgical equipment technology. This study analyzes the articles published about PCNL between 1975 and 2020 by using bibliometric and statistical methods and thus to holistically summarize and interpret PCNL by identifying the studies, institutions and journals with the highest impact, establishing trend topics and international collaboration among countries.

Materials and Methods

The Web of Science (WoS) database by Clarivate Analytics was used for literature review. "Percutaneous nephrolithotomy" and "PCNL" were used as search keywords in WoS. Publications were searched only in the "title" section of the studies. With this search method, all publications containing PCNL or PCNL in their title were obtained and downloaded from the WoS database. The search period was between the years 1975-2020 (access date: 15.01.2021, search findings may vary according to different access dates). Repeatability codes for researchers to access similar documents: [title: ("percutaneous nephrolithotomy") or title: ("PCNL") Timespan: 1975-2020. Indexes: SCI-Expanded, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI]. For bibliometric network visualizations, VOSviewer (Version 1.6.15, Leiden University's Center for Science and Technology Studies) package program was used (7). The website (https://app.datawrapper.de) was used to draw the world map.

Statistical Analysis

Statistical analysis was performed with SPSS (Version 22.0, SPSS Inc., Chicago, IL, USA, License: Hitit University) package program. The normal distribution of the data was tested with the Shapiro-Wilk test. The Spearman's correlation coefficient was used in accordance with the data distribution to calculate the correlations between the number of articles produced by the world countries and some economic development indicators of the world countries Gross Domestic Product (GDP), gross domestic product per capita (GDP per capita), gross domestic product at purchasing power parity (GDP PPP), Gross Domestic Product per capita at purchasing power parity (GDP per capita PPP) whose data were obtained from the world bank (https://data.worldbank.org/indicator/NY.GDP.MKTP.CD) to identify the effective indicators of academic productivity on PCNL. Nonlinear regression analysis was used to estimate the number of publications in the coming years. The R^2 value was used to evaluate the success of the model in regression analysis. A statistically significant difference was accepted as $p<0.05$.

Results

Because of the literature review, no publication was found on PCNL in the WoS database between the years 1975-1980. A total of 4170 publications were found between 1981-2020. The breakdown of the types of these publications was identified as follows; 1936 (46.4%) articles, 1594 (38.2%) meeting abstracts, 248 (5.9%) editorial materials, 191 (4.58%) letters, 160 (3.8%) reviews, 41 (0.9%) proceedings papers, and other types of publications (namely; early access, correction, note, book chapter, news item, reprint). Of these 4170 publications, bibliometric analyses were performed on 1936 articles. A total of 1856 (95.9%) articles were written in the English language and the rest in French (n=35), Spanish (n=26), German (n=13) and Turkish (n=6) languages. H-index, average citations per article and sum of times cited for 1936 articles were 74, 15.36 and 29730 (without self-citations: 15174), respectively.

Research Areas

The top research areas in PCNL are as follows: Urology nephrology (n=1564, 80.8%), medicine general internal (n=141, 7.3%), surgery (n=74, 3.8%), medicine research experimental (n=62, 3.2%), pediatrics (n=26, 1.3%), anesthesiology (n=25, 1.3%), radiology nuclear medicine medical imaging (n=22, 1.1%), multidisciplinary sciences (n=20, 1%), pharmacology pharmacy (n=11, 0.6%), public environmental occupational health (n=10, 0.5%).

Evolution of Publications and Future Trends

The distribution of the articles over the years is given in Figure 1. The results of the nonlinear (exponential model) regression analysis, used to estimate the number of articles in 2020 and beyond, are also shown in Figure 1. Based on the regression analysis results, it is estimated that 207 [confidence interval (CI)%: 181-233] articles will be published in 2021 and 251 (CI%: 218-283) articles in 2025.

Active Countries

The distribution of the articles over the countries in the world is given in Figure 2. Most productive countries (those producing 20 articles and more) over the number of articles ranked as Turkiye (n=376), the USA (n=332), China (n=323), India (n=210), Iran (n=123), the UK (n=118), Egypt (n=81), Canada (n=76), Germany (n=61), Italy (n=58), France (n=48), Spain (n=47), Taiwan (n=41), Netherlands (n=38), Pakistan (n=35), Israel (n=32), Greece (n=29), South Korea (n=24), Brazil (n=20), Thailand (n=20). The international collaboration network visualization map, demonstrating the collaboration between 38 countries, which produced minimum 5 articles out of the 60 countries producing publications on PCNL, is given in Figure 3a and the density map in Figure 3b.

Correlation Analysis

A moderate level of statistically significant positive correlation was found between the number of articles on PCNL produced by the countries and the GDP, GDP per capita, GDP PPP and GDP per capita PPP (r=0.653, p<0.001; r=0.548, p<0.001; r=0.607, p<0.001; r=0.512, p<0.001, respectively).

Active Authors

Most active authors producing 25 articles, and on PCNL were ranked as Zeng GH (n=53), Tepeler A (n=36), Binbay M (n=32), Unsal A (n=29), Zhao ZJ (n=29), Muslumanoglu AY (n=27), Wu WQ (n=25).

Active Institutions

The top 15 most actively publishing universities (those producing 20 articles and more) in this area ranked as; Guangzhou Medical University (n=63), University of Health Sciences Turkiye, İstanbul Haseki Training and Research Hospital (n=52), Başkent University (n=32), Bezmialem Foundation University (n=29), AMC Hospital (n=28), Huazhong University of Science and Technology (n=26), Duke University (n=25), All India Institute of Medical Sciences (n=24), Hacettepe University (n=24), Mansoura University (n=24), Muljibhai Patel Urological Hospital (n=24),

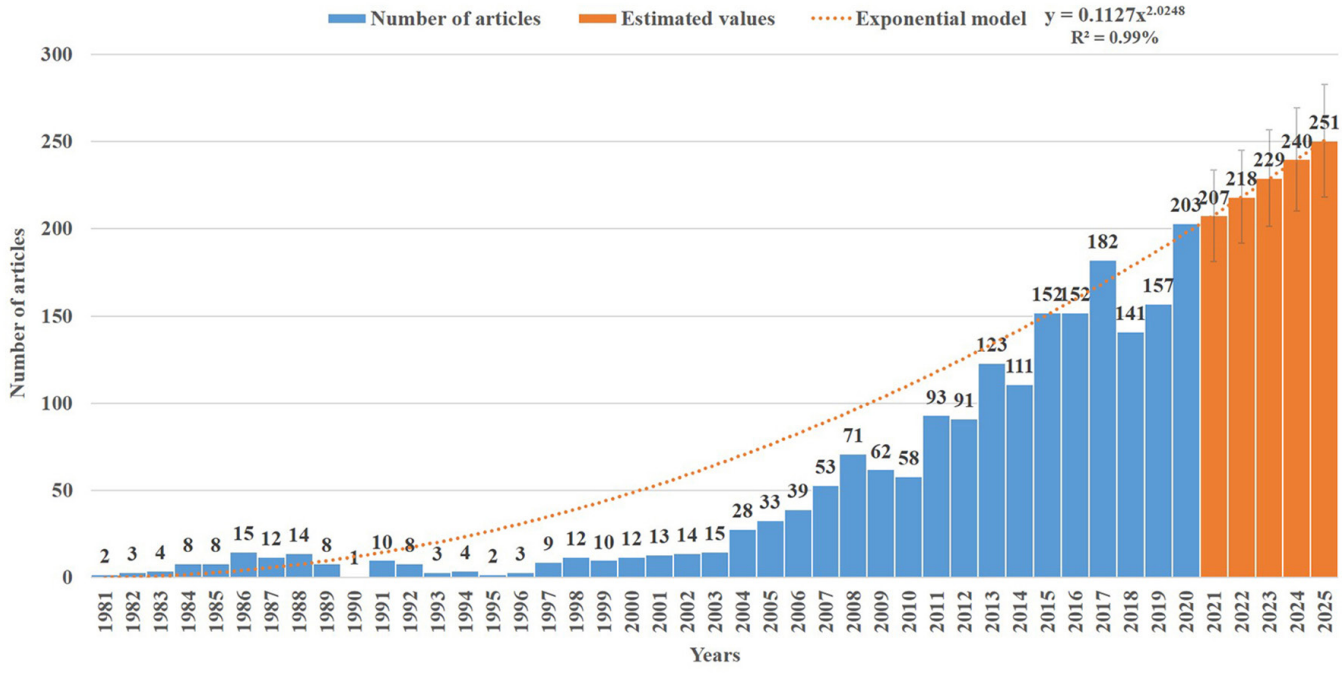

Figure 1. Number of articles published on percutaneous nephrolithotomy by years and estimation of the number of articles that can be published in the future

Dicle University (n=23), Sun Yat Sen University (n=23), Keçiören Training Research Hospital (n=20), Guangdong Key Laboratory of Urology (n=19).

Active Journals

A total of 1936 articles on PCNL have been published in 243 different journals. Out of these journals, top 35 most active journals, producing 10 articles and more, their sum of times cited and average citations per article are given in Table 1. The citation network visualization map between these journals is given in Figure 3c.. The top journal for the number of articles published was the Journal of Endourology (number of article: 376), the top journal for the number of citations was the Journal of Endourology (number of citation: 9326) and the top journal for average citations per article was European Urology (average citation per document 83.6).

Citation Analysis

The top 36 articles for the sum of times cited in the 1981-2020 period are presented in Table 2. Again, in the last column of Table 2, average citations of the articles per year are given. Accordingly, the most cited article was "The Clinical Research Office of the Endourological Society PCNL Global Study" by De la Rosette et al. (8). This study, published in 2011 in the Journal of Endourology focused on the indications, complications, and outcomes in 5803 patients (8).

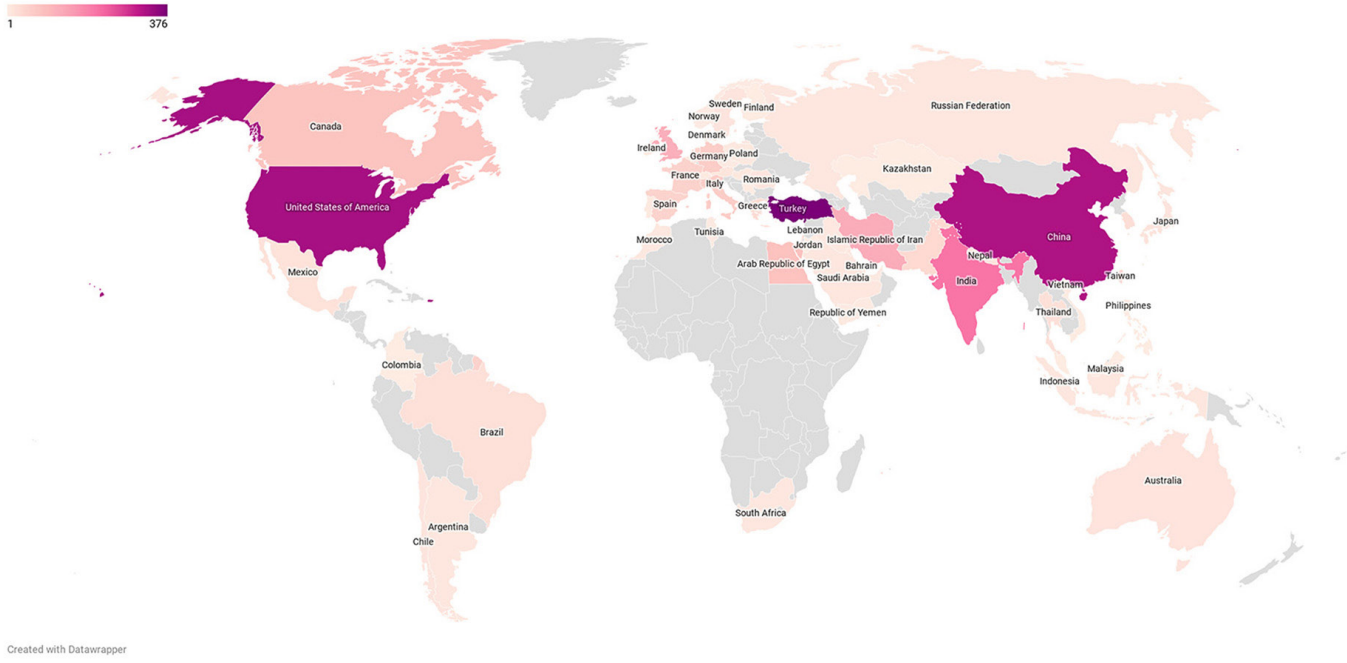

Figure 2. World map for the distribution of articles by country on percutaneous nephrolithotomy. **Footnote:** In the indicator given at the bottom left of the figure, productivity increases from green to red

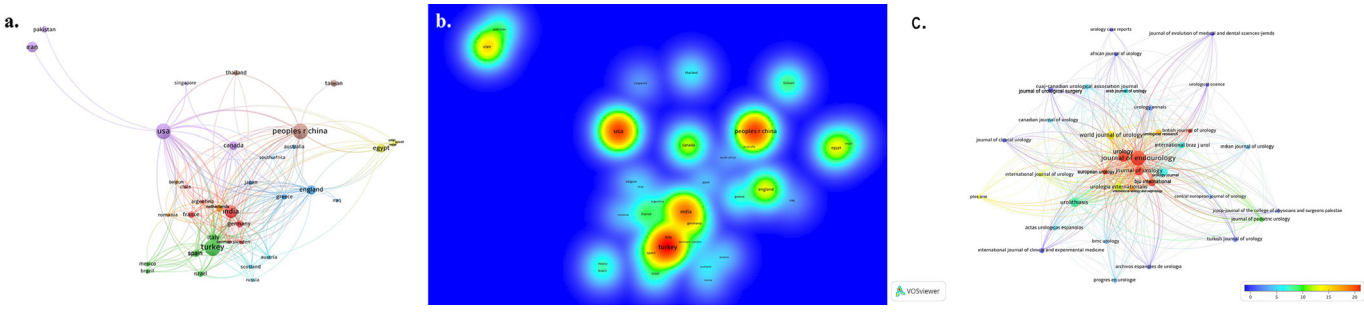

Figure 3. a. Network visualization map for international collaboration of worldwide countries on percutaneous nephrolithotomy. **Footnote:** The size of the circle shows the large number of articles, the thickness of the lines indicates the strength of relationship, and the colors show the different clusters. **b.** Density map for international collaboration of worldwide countries on percutaneous nephrolithotomy. **Footnote:** Cooperation increases from blue to red (blue-green-yellow-red). **c.** Network visualization map for citation analysis of active journals on percutaneous nephrolithotomy. Footnote: The size of the circle shows the large number of articles. The number of citations from blue to red (blue-green-yellow-red) increases

Co-citation Analysis

A total of 11068 articles were cited under the references section of all the analyzed articles. The top 8 studies, with more than 150 co-citations under the references section, were ranked as follows: Fernstrom (number of co-citations, NC: 373), Michel (NC: 279), Preminger (NC: 263), de la Rosette (NC: 251), Tefekli (NC: 192), Dindo (NC: 185), Kukreja (NC: 169), Bellman (NC: 153) (9-16).

Trend Topics

In total, 1718 different keywords were used in all 1936 articles published on PCNL. Seventy-eight keywords were used in at least 10 different articles about these words (Table 3). The trend visualization network map is given in Figure 4a and the citation network visualization map in Figure 4b. A cluster network visualization map between these keywords is given in Figure 4c.

Table 1. Most active journals on PCNL

Journals	RC	C	AC	Journals	RC	C	AC
Journal of Endourology	376	9326	24.8	Progres En Urologie	19	80	4.2
Urology	149	3699	24.8	BMC Urology	17	68	4.0
Journal of Urology	111	4393	39.6	Journal of Pediatric Urology	17	172	10.1
Urolithiasis	110	908	8.3	Actas Urologicas Espanolas	16	86	5.4
World Journal of Urology	77	1117	14.5	Arab Journal of Urology	15	105	7.0
Urology Journal	71	496	7.0	British Journal of Urology	15	349	23.3
Urologia Internationalis	71	869	12.2	Canadian Journal of Urology	15	70	4.7
BJU International	56	1748	31.2	Indian Journal of Urology	15	60	4.0
International Brazilian Journal of Urology	34	241	7.1	Journal of Clinical Urology	14	11	0.8
Urological Research	33	543	16.5	Journal of Evolution of Medical and Dental Sciences-Jemds	14	4	0.3
CUAJ-Canadian Urological Association Journal	29	141	4.9	International Journal of Urology	14	168	12.0
Urology Annals	26	71	2.7	Plos One	11	158	14.4
International Urology and Nephrology	26	450	17.3	Urology Case Reports	11	4	0.4
International Journal of Clinical and Experimental Medicine	23	15	0.7	Urological Science	11	9	0.8
Journal of Urological Surgery	21	15	0.7	African Journal of Urology	10	8	0.8
Turkish Journal of Urology	21	37	1.8	Central European Journal of Urology	10	32	3.2
Archivos Espanoles De Urologia	19	32	1.7	JCPSP-Journal of the College of Physicians and Surgeons Pakistan	10	16	1.6
European Urology	19	1588	83.6				

RC: Record count, C: Number of citation, AC: Average citation per document

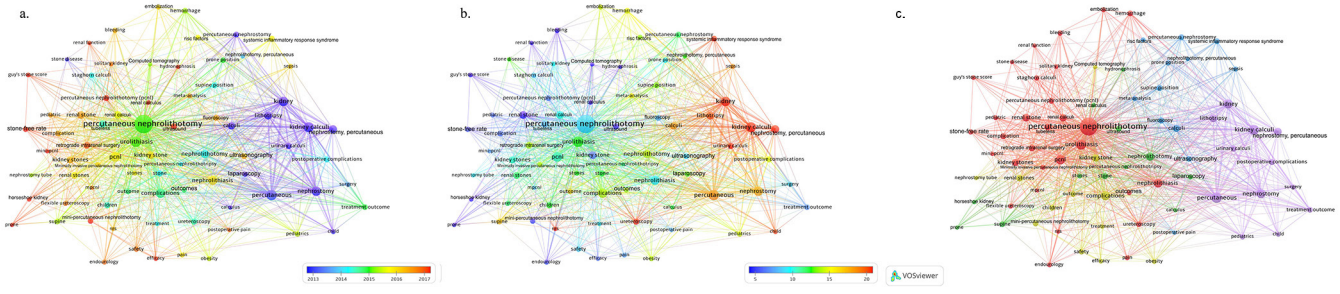

Figure 4. a. Network visualisation map for trends on percutaneous nephrolithotomy Footnote: Indicator shows current publications from blue to red (blue-green-yellow-red). **b.** Network visualization map of the most frequently cited topics on percutaneous nephrolithotomy **Footnote:** The number of citations from blue to red increases. **c.** Network visualisation map for cluster analysis based on keyword analysis on percutaneous nephrolithotomy. **Footnote:** Colors show clustering. Keywords in the same cluster are of the same color

Table 2. Top 25 most cited articles according to total citations on PCNL

No	Article	Author	Journal	PY	TC	AC
1	The clinical research office of the endourological society percutaneous nephrolithotomy global study: Indications, complications, and outcomes in 5803 patients	de la Rosette et al. (8)	Journal of Endourology	2011	430	39.09
2	First prize - factors affecting blood loss during percutaneous nephrolithotomy: Prospective study	Kukreja et al. (15)	Journal of Endourology	2004	297	16.5
3	Classification of percutaneous nephrolithotomy complications using the modified clavien grading system: Looking for a standard	Tefekli et al. (13)	European Urology	2008	292	20.86
4	The mini-perc technique: A less invasive alternative to percutaneous nephrolithotomy	Jackman et al. (23)	World Journal of Urology	1998	222	9.25
5	Percutaneous nephrolithotomy in infants and preschool age children: Experience with a new technique	Jackman et al. (24)	Urology	1998	213	8.88
6	Complications of percutaneous nephrolithotomy	Lee et al. (25)	American Journal of Roentgenology	1987	204	5.83
7	Categorisation of complications and validation of the clavien score for percutaneous nephrolithotomy	de la Rosette et al. (12)	European Urology	2012	187	18.7
8	Percutaneous nephrolithotomy with ultrasonography-guided renal access: Experience from over 300 cases	Osman et al. (26)	BJU International	2005	186	10.94
9	The guy's stone score-grading the complexity of percutaneous nephrolithotomy procedures	Thomas et al. (27)	Urology	2011	180	16.36
10	Estimated blood-loss and transfusion rates associated with percutaneous nephrolithotomy	Stoller et al. (28)	Journal of Urology	1994	167	5.96
11	Post-percutaneous nephrolithotomy extensive hemorrhage: a study of risk factors	El-Nahas et al. (29)	Journal of Urology	2007	164	10.93
12	Single-step percutaneous nephrolithotomy (microperc): The initial clinical report	Desai et al. (30)	Journal of Urology	2011	162	14.73
13	Stone and pelvic urine culture and sensitivity are better than bladder urine as predictors of urosepsis following percutaneous nephrolithotomy: A prospective clinical study	Mariappan et al. (31)	Journal of Urology	2005	148	8.71
14	Endoscopic combined intrarenal surgery in galdakao-modified supine valdivia position: a new standard for percutaneous nephrolithotomy?	Scoffone et al. (32)	European Urology	2008	146	10.43
15	Percutaneous nephrolithotomy - extraction of renal and ureteral calculi from 100 patients	Clayman et al. (33)	Journal of Urology	1984	145	3.82
16	Vascular complications after percutaneous nephrolithotomy: Are there any predictive factors?	Srivastava et al. (34)	Urology	2005	138	8.12
17	Minimally invasive PCNL in patients with renal pelvic and calyceal stones	Lahme et al. (35)	European Urology	2001	129	6.14
18	Percutaneous nephrolithotomy for complex pediatric renal calculus disease	Desai et al. (22)	Journal of Endourology	2004	128	7.11
19	Prospective randomized study of various techniques of percutaneous nephrolithotomy	Feng et al. (37)	Urology	2001	128	6.1
20	A nephrolithometric nomogram to predict treatment success of percutaneous nephrolithotomy	Smith et al. (38)	Journal of Urology	2013	122	13.56
21	Modified supine versus prone position in percutaneous nephrolithotomy for renal stones treatable with a single percutaneous access: a prospective randomized trial	De Sio et al. (39)	European Urology	2008	119	8.5
22	The percutaneous nephrolithotomy global study: classification of complications	Labate et al. (40)	Journal of Endourology	2011	116	10.55
23	The all-seeing needle: Initial results of an optical puncture system confirming access in percutaneous nephrolithotomy	Bader et al. (41)	European Urology	2011	114	10.36
24	Percutaneous nephrolithotomy: Variables that influence hemorrhage	Turna et al. (42)	Urology	2007	114	7.6
25	Operating times and bleeding complications in percutaneous nephrolithotomy: A comparison of tract dilation methods in 5537 patients in the clinical research office of the endourological society percutaneous nephrolithotomy global study	Yamaguchi et al. (43)	Journal of Endourology	2011	113	10.27

PY: Publication year, TC: Total citation, AC: Average citations per year

Table 3. Top 78 most used keywords in articles published on PCNL

Keywords	Number of uses	Keywords	Number of uses	Keywords	Number of uses
Percutaneous nephrolithotomy	717	Fluoroscopy	25	Pain	15
Percutaneous	135	Children	24	Pediatric	15
Urolithiasis	126	Ultrasound	24	Surgery	15
Kidney calculi	121	Ureteroscopy	24	Embolization	14
Pcnl	103	Hemorrhage	22	Child	13
Kidney	94	Percutaneous nephrostomy	22	Efficacy	13
Nephrostomy	92	Treatment outcome	22	Guy's stone score	13
Complications	91	Ultrasonography	22	Renal calculus	13
Nephrolithiasis	86	Supine	21	Risk factors	13
Nephrolithotomy	60	Systemic inflammatory response syndrome	21	Solitary kidney	13
Nephrostomy, percutaneous	59	Safety	20	Stones	12
Renal stone	55	Staghorn calculi	20	Nephrolithotomy, percutaneous	11
Lithotripsy	54	Stone-free rate	19	Nephrostomy tube	11
Kidney stone	52	Outcome	18	Percutaneous nephrolithotripsy	11
Renal calculi	51	Bleeding	17	Postoperative pain	11
Calculi	44	Mini-percutaneous nephrolithotomy	17	Renal function	11
Kidney stones	41	Pediatrics	17	Treatment	11
Tubeless	39	Prone position	17	Calculus	10
Renal stones	34	Flexible ureteroscopy	16	Computed tomography	10
Retrograde intrarenal surgery	34	Minimally invasive percutaneous nephrolithotomy	16	Horseshoe kidney	10
Complication	28	Outcomes	16	Hydronephrosis	10
Urinary calculi	28	Sepsis	16	Mini-PCNL	10
Percutaneous nephrolithotomy (PCNL)	27	Endourology	15	MPCNL	10
Postoperative complications	27	Laparoscopy	15	Prone	10
Supine position	27	Meta-analysis	15	Rirs	10
Stone	26	Obesity	15	Stone disease	10

Discussion

According to the data presented in our study, there has been an exponential increase in the number of PCNL-related publications recently. Between 1981 and 2003, 9 articles on average were published annually, while the number of studies on PCNL have significantly increased after 2004 reaching in average 157 articles annually between 2015 and 2019 with a peak in 2020 (203 articles). Regression analysis results show that the growing number of articles will continue exponentially in the coming years.

With a look into the distribution of publications among different countries, 12 out of the 20 most active countries on PCNL are developed countries, whereas the rest are developing countries. It is quite interesting that Turkiye is the most active country in producing publications ranking in the top 5 with China, India, Iran and Egypt. Developed countries, such as Canada, Germany, Italy, France, Spain, Taiwan and the Netherlands follow. We think that this situation may be related to the habits of patients living in these regions to apply to health institutions and for this reason it is known that the time-case distribution directly affects the level of scientific analysis. It has been shown in the literature that the developed countries have a critical role in bibliometric analysis and effective publications in many fields of medicine with a significant level of correlation to their economic power (5,6). Our study, on the other hand, presents a moderate level of significance between article productivity and indicators of economic development according to correlation

analysis results. The age interval of societies that encounter urinary stone disease depends on climate conditions, nutritional habits and genetic background (17). We think that this leads to a huge variety in the level of scientific activities in different geographies. In connection, we also believe that this situation may have led to an uneven distribution of countries involved in bibliometric studies.

In some studies in the literature, it has been stated that geographical neighborhoods are effective in international cooperation (5-7). One may conclude that these countries had also preceded international cooperation.

As for the keyword analysis results, 5 clusters in different colors come up in PCNL-related topics. The mostly cited keywords are systemic inflammatory response syndrome, retrograde intrarenal surgery, sepsis, lithotripsy, ureteroscopy, kidney, kidney calculi, and urinary calculi. Analysis of trending topics indicates that recently the most studied keywords are mini PCNL, stone-free rate, Guy's stone score, retrograde intrarenal surgery, prone, horseshoe kidney, ultrasound, renal calculus, renal function, hydronephrosis, postoperative pain, efficacy, and safety. In our study, it was observed that the increasing level of interest in PCNL was intensively studied to provide an effective and safe surgical approach for patients.

Success rates of PCNL depend closely on many factors, including the clinical experience of the institution, use of proper surgical equipment, patient-related anatomical factors, stone size and localization. Large series indicate an average success rate of 85-93% (18). Our study concluded that keywords depicting the consequences of this surgical intervention, such as efficacy and stone-free rate are searched with a growing interest in the scientific community working on PCNL. However, with the changing success rates, the medical community has grown with interest in which patient groups might benefit more from PCNL. In this context, it has been observed that the Guy's scoring system has been used with increasing trend for quantitative assessment of kidney stones by using stone and patient characteristics. Although PCNL has been shown as a minimally invasive treatment strategy, it involves many complications ranging from blood loss to adjacent organ injuries and renal pelvic perforations to fever and urinary fistulas. Large-scaled studies reported complication rates at the level of 14.5% (19). It is quite critical that patients get the least harm from this surgical procedure. Therefore, words safety, renal function and postoperative pain are quite trendy. However, surgical techniques that affect both the efficacy and reliability of PCNL are quite important. As a direct consequence of this, it was possible to see in our study that mini PCNL and prone position are the other words most often searched recently.

It has been thought that there are mainly two reasons why mini PCNL has been highly regarded in the medical community. One because the patients apply to health institutions earlier due to improving socioeconomic conditions in many parts of the world, because of which there has been an increase in the prevalence of small to medium sized kidney stones. And two, because there is minimized PCNL surgical equipment available for less traumatic surgery thanks to the technological developments. In a quite comprehensive meta-analysis by Zhu et al. (20), authors looked into eight publications and 749 patient results and reported that mini PCNL provides a more effective and reliable treatment modality versus PCNL. In another current study, Thapa and Niranjan (21) reported that mini PCNL provides a more effective and lower risk operation than PCNL considering lower bleeding and hospitalization times. The decision of whether to use PCNL in the prone or supine position is still controversial. In a relatively current systematic review and meta-analysis by Birowo et al. (22), concluded that surgical experience is quite an important factor with no significant difference between the two techniques in terms of hospitalization and surgical times. In the same study, it was reported that the prone position had a higher stone-free rate yet with higher major complication rate compared to the supine position. Our study has put forth that together the technological developments and different surgical techniques for treating kidney stones and miniaturized surgical equipment, PCNL will become more popular a more reliable and effective approach.

This comprehensive study on PCNL is the first bibliometric research. We are of in the opinion that the use of comprehensive statistical methods such as keyword cluster analysis, trending keyword analysis, correlation and regression analysis in addition to descriptive statistics and citation analyses are the strength of our study.

Study Limitations

The main limitation of our study is the use of only the WoS database in the literature review. PubMed and Scopus databases were not used in our study. This is mainly because citation and co-citation analysis cannot be performed with the PubMed database for an effective pick of studies and journals. The Scopus database may also include studies with a relatively lower impact level. Recent bibliometric analysis revealed that WoS is a more preferred alternative (5,6). The main reason is that the WoS database indexes articles published in journals with a higher impact (5). Therefore, our study used only the WoS database.

Conclusion

This comprehensive bibliometric study on PCNL that has been increasing trend in more articles every other day in the literature, provides an abstract of 1936 articles published on PCNL between 1975-2020. It is noted that publication has recently focused on

more effective and safer surgical techniques. In this context, it has been observed that surgical techniques and preoperative patient analyzes related to PCNL have attracted considerable interest in our century.

Ethics

Ethics Committee Approval: This article does not contain any studies with human participants or animals performed by any author.

Informed Consent: For this type of study formal consent is not required.

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Authorship Contributions

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