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Ultrasonography in Anesthesiology: A Bibliometric Analysis of the Most Cited Articles

Anesteziyolojide Ultrasonografi: En Çok Atıf Alan Makalelerin Bibliyometrik Analizi

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Abstract

Aim: Ultrasonography (USG) has become a critical tool in anesthesiology, enhancing the safety and efficacy of nerve blocks, vascular interventions, and perioperative procedures. This study aims to perform a bibliometric analysis of the most cited articles on USG use in anesthesiology to identify trends and impactful research.

Material and Method: A bibliometric, descriptive, and analytical study was conducted using the Scopus database. The search terms "ultrasonography and anesthesiology" yielded 704 articles. After excluding reviews, letters, editorials, notes, conference papers, book chapters, and retracted papers, 337 original research articles remained. These were ranked by citation count and analyzed. Data collected included the first author, publication year, article title, journal title, main subject, academic specialization of the first author, institution, country of origin, and citation information. The median number of citations per year and journal impact factors were calculated.

Results: The median number of citations for the 100 most cited articles was 18. The most cited article, authored by Ramsing D., received 91 citations. Anesthesiologists authored 78% of these top-cited articles. The primary focus areas included peripheral nerve blocks, central nerve blocks, and catheterization. The median number of citations per year was 2.85.

Conclusion: The increasing use of USG in anesthesiology is reflected in the high citation rates of related studies, most of which were published in reputable journals. This trend underscores the importance of USG in enhancing clinical practice and the influence of robust financial and technical support on research impact.

Keywords: Anesthesiology, ultrasonography, nerve blocks, bibliometric analysis, citation analysis

Öz

Amaç: Ultrasonografi (USG); anesteziyolojide sinir blokları, vasküler girişimler ve perioperatif işlemlerin güvenliği ve etkinliğini arttıran önemli bir araç halini almıştır. Bu çalışma, anesteziyolojide USG kullanımına ilişkin en çok alıntı yapılan makalelerin bibliyometrik analizinin yapılması amaçlanmıştır.

Gereç ve Yöntem: Scopus veri tabanı kullanılarak bibliyometrik, tanımlayıcı ve analitik bir çalışma yapıldı. "Ultrasonografi ve anesteziyoloji" arama terimleri için, 704 makale listelendi. İncelemeler, mektuplar, başyazılar, notlar, konferans makaleleri, kitap bölümleri ve geri çekilmiş makaleler dışlandığında geriye 337 orijinal araştırma makalesi kaldı. Bunlar alıntı sayısına göre sıralanarak, analiz edildi. Toplanan veriler arasında ilk yazar, yayın yılı, makale başlığı, dergi başlığı, ana konu, ilk yazarın akademik uzmanlığı, kurumu, menşe ülkesi ve atıf bilgileri yer almaktadır. Ayrıca, yıllık ortalama atıf sayısı ve dergi etki faktörleri de hesaplandı.

Bulgular: En çok atıf alan 100 makalenin ortanca atıf sayısı 18 oldu. En çok atıf alan Ramsing D.'nin makalesi ise 91 atıf almıştı. En çok alıntı yapılan makalelerin %78'inin, anestezistler tarafından yazıldığı saptandı. Bu makalelerin primer olarak periferik sinir blokları, merkezi sinir blokları ve kateterizasyon konularına odaklandığı saptandı. Ayrıca, yıllık ortalama atıf sayısının da 2,85 olduğu görüldü.

Sonuç: Anesteziyolojide USG kullanımdaki artış, saygın dergilerde yayınlanmış olan ilgili çalışmaların yüksek atıf oranlarına da yansımaktadır. Bu trend, USG'nin klinik uygulamaları geliştirmedeki önemini vurgulamaktadır. Ve ayrıca, güçlü mali ve teknik desteğin araştırmalarını üzerindeki etkisini de göstermektedir.

Anahtar Kelimeler: Anesteziyoloji, ultrasonografi, sinir blokları, bibliometrik analiz, atıf analizi

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INTRODUCTION

Innovative technologies in recent years have caused significant advances in the field of health care, as in many other fields. Especially, imaging methods have enabled interventional procedures to be performed more safely and effectively with lesser complications.[1] Ultrasonographic imaging methods are used in many areas of medicine. The use of ultrasonography (USG) in anesthesiology and reanimation has also increased in recent years. High-resolution real-time imaging of anatomical structures with USG, especially before interventional invasive procedures, ensures successful and rapid completion of nerve blocks, vascular interventions, and perioperative procedures performed in anesthesiology.[2,3] In parallel with the widespread use of USG in anesthesiology, the number of publications in this field has also increased. Bibliometric analyses provide guidance to academicians about the content and quality of publications on a particular subject.[4] In this context, this bibliometric analysis was conducted to identify the top 100 articles with the highest number of citations on the use of USG in anesthesiology and describe the characteristics of these articles.

MATERIAL AND METHOD

This study was designed as a bibliometric, descriptive, and analytical analysis. The study material consisted of 704 articles obtained as a result of the search conducted in the Scopus citation database using the keywords "ultrasonography and anesthesiology" on January 1st, 2023.

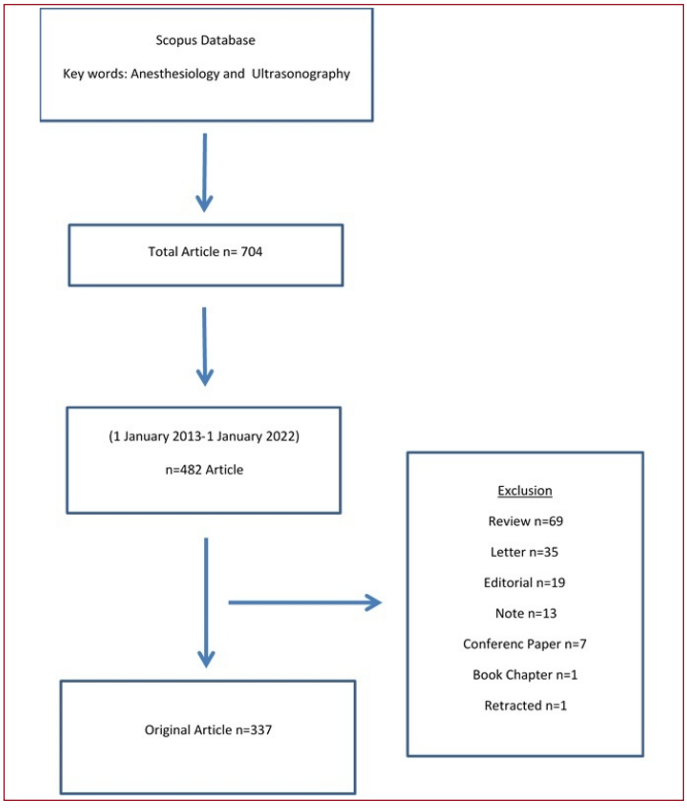

Figure 1. Flow Chart

482 articles were published between 2013 and 2022.[5] While articles focusing on the use of USG in anesthesiology were included in the study, publications such as reviews, letters, editorials, notes, conference papers, book chapters, and retracted papers were excluded from the study (**Figure 1**). The remaining 337 original research articles were listed in **Table 1**. And, all articles were reviewed in detail by an anesthesiologist. For each article, descriptive data such as the first author, publication year and title of the article, the title, main subject, genre and publication language of the journal in which the article was published, the academic specialization of the first author of the article and the institution where he/she was working at the time of submission of the article, country of origin of the article and citation information were obtained from the Scopus database and recorded. The median number of citations received by the article per year was calculated with using the formula below:

Median number of citations per year=total number of citations/[2023-year of publication])

The impact factors (IF) of the journals where the articles were published were viewed on the official websites of the journals. The articles were classified according to the academic specializations of their first authors, i.e., [1] Anesthesiology and Reanimation, [2] Biomedical Engineering, [3] Electrical and Computer Engineering, [4] Emergency Medicine, [5] Surgery and [6] Others, as well as their country of origin.

The research data evaluated online and collected on data forms were expressed using descriptive statistics such as median [interquartile range (IQR), 25th-75th percentile] and frequency (n) and percentage (%) values. Bar and pie charts were used to represent the data graphically.

RESULTS

Of the 337 original research articles on the use of USG in anesthesiology reviewed within the scope of the research, top 100 articles with the highest number of citations were listed in descending order for citations (**Table 1**). The median number of citations per year of the all articles was 18 (14-27.75). While the article by Ramsing D.[6] was the most cited article with 91 citations in the list, the article by Woodland DC.[7] was the least cited (**Table 1**). Among the all study articles, Frykholm P.'s article,[8] the most recently published article, which was published in 2022, received 17 citations. The number of first authors with two articles on the list was 7. These authors are Batker M, Lufting J, Mariano E, Ramsing D, Tran D, Woodworth G.E, and Yu S.[6,9,10-14] Thus, the 100 most cited articles were authored by 93 first authors. Ramsing D. stood out in that two articles, of which he was the first author, were included in the 100 most cited articles, and one of these articles was the most cited article in the list. Two of the 100 most cited articles were published in French, one in German, and the others in English.

Table 1.The most-cited 100 manuscript on ultrasound in anesthesiology between 2012 and 2023 years

Rank	First Author	Total Citations	Title	Journal	Year
1	Ramsingh D	91	Impact assessment of perioperative point-of-care ultrasound training on anesthesiology residents	Anesthesiology	2015
2	Marhofer D	83	Magnetic resonance imaging analysis of the spread of local anesthetic solution after ultrasound-guided lateral thoracic paravertebral blockade: A volunteer study	Anesthesiology	2013
3	Mahmood F	77	Perioperative ultrasound training in anesthesiology: A call to action	Anesth Analg	2016
4	Bouvet L	71	Real-time detection of gastric insufflation related to facemask pressure-controlled ventilation using ultrasonography of the antrum and epigastric auscultation in nonparalyzed patients	Anesthesiology	2014
5	Luftig J	68	Successful emergency pain control for posterior rib fractures with ultrasound-guided erector spinae plane block	Am J Emerg Med	2018
6	Berk D	65	Ultrasound-guided radial arterial cannulation: Long axis/in-plane versus short axis/ out-of-plane approaches?	J Clin Monit Comput	2013
7	Sahin L	54	Ultrasound-guided transversus abdominis plane block in children: A randomised comparison with wound infiltration	Eur J Anaesthesiol	2013
8	Tiran E	51	Transcranial Functional Ultrasound Imaging in Freely Moving Awake Mice and Anesthetized Young Rats without Contrast Agent	Ultrasound Med Biol	2017
9	Lamb A	51	Accuracy of identifying the cricothyroid membrane by anesthesia trainees and staff in a Canadian institution	Can J Anesth	2015
10	Yu S	45	Lumbar Ultrasound Image Feature Extraction and Classification with Support Vector Machine	Ultrasound Med Biol	2015
11	Andruszkiewicz P	41	Effectiveness and validity of sonographic upper airway evaluation to predict difficult laryngoscopy	J Ultrasound Med	2016
12	Sultan S	41	Simulators for training in ultrasound guided procedures	Med Ultrasonography	2013
13	Mariano E	38	A randomized comparison of proximal and distal ultrasound-guided adductor canal catheter insertion sites for knee arthroplasty	J Ultrasound Med	2014
14	Wong S	34	Real-time ultrasound-guided spinal anesthesia using the SonixGPS needle tracking system: A case report	Can J Anesth	2013
15	Dres M	34	Usefulness of Parasternal Intercostal Muscle Ultrasound during Weaning from Mechanical Ventilation	Anesthesiology	2020
16	Ramsingh D	34	Comparison of the didactic lecture with the simulation/model approach for the teaching of a novel perioperative ultrasound curriculum to anesthesiology residents	J Clin Anesth	2014
17	Smistad E	32	Real-Time Automatic Artery Segmentation, Reconstruction and Registration for Ultrasound-Guided Regional Anaesthesia of the Femoral Nerve	IEEE Trans Med Imaging	2016
18	Batker M	32	Routine pre-operative focused ultrasonography by anesthesiologists in patients undergoing urgent surgical procedures	Acta Anaesthesiol Scand	2014
19	Zimmerman J	31	The Nuts and Bolts of Performing Focused Cardiovascular Ultrasound (FoCUS)	Anesth Analg	2017
20	Tran D	31	Primary failure of thoracic epidural analgesia in training centers: The invisible elephant?	Reg Anesth Pain Med	2016
21	Peters C	31	Ultrasound guidance versus direct palpation for radial artery catheterization by expert operators: a randomized trial among Canadian cardiac anesthesiologists	Can J Anesth.	2015
22	Sviggum H	31	Needle echogenicity in sonographically guided regional anesthesia blinded comparison of 4 enhanced needles and validation of visual criteria for evaluation	J Ultrasound Med	2013
23	Yu X	30	Performance of Lung Ultrasound in Detecting Peri-Operative Atelectasis after General Anesthesia	Ultrasound Med Biol	2016
24	Aksu C	29	Analgesic effect of the bi-level injection erector spinae plane block after breast surgery: A randomized controlled trial	Agri	2019
25	Goettel N	28	Monitoring of cerebral blood flow autoregulation in adults undergoing sevoflurane anesthesia: a prospective cohort study of two age groups	J Clin Monit Comput	2016
26	Pesteie M	27	Automatic Localization of the Needle Target for Ultrasound-Guided Epidural Injections	IEEE Trans Med Imaging	2018
27	Diaz gomez J	27	Impact of a focused transthoracic echocardiography training course for rescue applications among anesthesiology and critical care medicine practitioners: A prospective study	J Cardiothorac Vasc Anesth	2015
28	Kessler J	27	Ultrasound-guided regional anesthesia: Learning with an optimized cadaver model	Surg Radiol Anat	2014
29	Woodworth G	26	Efficacy of computer-based video and simulation in ultrasound-guided regional anesthesia training	J Clin Anesth	2014
30	Conway D	26	A comparison of noninvasive bioreactance with oesophageal Doppler estimation of stroke volume during open abdominal surgery: An observational study	Eur J Anaesthesiol	2013
31	Mariano E	26	A randomized comparison of longand short-axis imaging for in-plane ultrasound-guided femoral perineural catheter insertion	J Ultrasound Med	2013
32	Dobson G	25	Guidelines to the Practice of Anesthesia - Revised Edition 2017	Can J Anaesth	2017
33	Munirama S	25	Physical properties and functional alignment of soft-embalmed Thiel human cadaver when used as a simulator for ultrasound-guided regional anaesthesia	Br J Anaesth	2016
34	Dal Moro F	24	Ultrasound-guided transversus abdominis plane block (US-TAPb) for robot-assisted radical prostatectomy: a novel four-point technique results of a prospective, randomized study	J Rob Surg	2019

Table 1.The most-cited 100 manuscript on ultrasound in anesthesiology between 2012 and 2023 years (Cont...)

Rank	First Author	Total Citations	Title	Journal	Year
35	Borg LK	24	Preliminary Experience Using Eye-Tracking Technology to Differentiate Novice and Expert Image Interpretation for Ultrasound-Guided Regional Anesthesia	J Ultrasound Med	2018
36	Corvetto M	24	Simulation-based training program with deliberate practice for ultrasound-guided jugular central venous catheter placement	Acta Anaesthesiol Scand	2017
37	Lee D	24	Ultrasound evaluation of the radial artery for arterial catheterization in healthy anesthetized patients	J Clin Monit Comput	2016
38	McGraw R	23	Development and evaluation of a simulation-based curriculum for ultrasound-guided central venous catheterization	Can J Emerg Med	2016
39	McVicar J	22	Novice performance of ultrasound-guided needling skills: Effect of a needle guidance system	Reg Anesth Pain Med	2015
40	Edrich T	22	A Comparison of Web-Based with Traditional Classroom-Based Training of Lung Ultrasound for the Exclusion of Pneumothorax	Anesth Analg	2016
41	Harrison T	22	Feasibility of eye-tracking technology to quantify expertise in ultrasound-guided regional anesthesia	J Anesth	2016
42	Kan J	22	An in vitro study to evaluate the utility of the "air test" to infer perineural catheter tip location	J Ultrasound Med	2013
43	Batker M	21	Implementing point-of-care ultrasonography of the heart and lungs in an anesthesia department	Acta Anaesthesiol Scand	2017
44	Ramlogan R	20	A virtual reality simulation model of spinal ultrasound: Role in teaching spinal sonoanatomy	Reg Anesth Pain Med	2017
45	Wang Q	19	Comparison of the effects of ultrasound-guided erector spinae plane block and wound infiltration on perioperative opioid consumption and postoperative pain in thoracotomy,	J Coll Phys Surg Pak	2019
46	Tran D	19	Beyond Ultrasound Guidance for Regional Anesthesiology	Reg Anesth Pain Med	2017
47	Defosse J	19	A Germany-wide survey on anaesthesia in thoracic surgery	Anaesthesist	2014
48	Laurent DA	19	A valid and reliable assessment tool for remote simulation-based ultrasound-guided regional anesthesia	Reg Anesth Pain Med	2014
49	Uppal V	18	Effect of beam steering on the visibility of echogenic and non-echogenic needles: a laboratory study	Can J Anesth	2017
50	Gopalasingam N	18	Ultrasound-guided radial artery catheterisation increases the success rate among anaesthesiology residents: A randomised study	J Vasc Access	2017
51	Kant A	18	Application of the continual reassessment method to dose-finding studies in regional anesthesia: An estimate of the ED95 dose for 0.5% bupivacaine for ultrasound-guided supraclavicular block,2013,	Anesthesiology	2013
52	Ashab H	18	An augmented reality system for epidural anesthesia (AREA): Prepuncture identification of vertebrae	Anesthesiology	2013
53	Frykholm P	17	Pre-operative fasting in children: A guideline from the European Society of Anaesthesiology and Intensive Care	IEEE Trans Biomed Eng	2022
54	Mok D	17	Point-of-care ultrasonography in Canadian anesthesiology residency programs: a national survey of program directors	Eur J Anaesthesiol	2017
55	Gurkan Y	17	One operators experience of ultrasound guided lumbar plexus block for paediatric hip surgery	J Clin Monit Comput	2017
56	Barrington M	17	Determining the Learning Curve for Acquiring Core Sonographic Skills for Ultrasound-Guided Axillary Brachial Plexus Block	Reg Anesth Pain Med	2016
57	Udani AD	17	Comparative-effectiveness of simulation-based deliberate practice versus self-guided practice on resident anesthesiologists' acquisition of ultrasound-guided regional anesthesia skills	Reg Anesth Pain Med	2016
58	Kokofer A	17	Ropivacaine 0.375% vs. 0.75% with prilocaine for intermediate cervical plexus block for carotid endarterectomy: A randomised trial	Eur J Anaesthesiol	2015
59	Alvarez-Diaz N	17	Comparison between transthoracic lung ultrasound and a clinical method in confirming the position of double-lumen tube in thoracic anaesthesia. A pilot study	Rev Esp Anestesiol Reanim	2015
60	Dolu H	17	Comparison of an ultrasound-guided technique versus a landmark-guided technique for internal jugular vein cannulation	J Clin Monit Comput	2015
61	Yu S	17	Automatic Identification of Needle Insertion Site in Epidural Anesthesia with a Cascading Classifier	Ultrasound Med Biol	2014
62	Steinfelt T	17	Nerve localization for peripheral regional anesthesia. Recommendations of the German Society of Anaesthesiology and Intensive Care Medicine	Anaesthesist	2014
63	Barbe N	17	Locating the cricothyroid membrane in learning phase: Value of ultrasonography?	Ann Fr Anesth Reanim	2014
64	Liu Y	17	Comparison of the development of performance skills in ultrasound-guided regional anesthesia simulations with different phantom models	Simul Healthc	2013
65	Whittaker S	17	An ultrasound needle insertion guide in a porcine phantom model	Anaesthesia	2013
66	Adler AC	16	Cardiac and lung point-of-care ultrasound in pediatric anesthesia and critical care medicine: Uses, pitfalls, and future directions to optimize pediatric care	Paediatr Anaesth	2019
67	Sujata N	15	A randomised trial to compare the increase in intracranial pressure as correlated with the optic nerve sheath diameter during propofol versus sevoflurane-maintained anesthesia in robot-assisted laparoscopic pelvic surgery	J Rob Surg	2019

Table 1.The most-cited 100 manuscript on ultrasound in anesthesiology between 2012 and 2023 years (Cont...)

Rank	First Author	Total Citations	Title	Journal	Year
68	Oliveira KF	15	Determining the amount of training needed for competency of anesthesia trainees in ultrasonographic identification of the cricothyroid membrane	BMC Anesthesiol	2017
69	Koskinen L	15	Can intracranial pressure be measured non-invasively bedside using a two-depth Doppler-technique?	J Clin Monit Comput	2017
70	Mariano ER	15	Evaluation of a standardized program for training practicing anesthesiologists in ultrasound-guided regional anesthesia skills	Anesth Pain Med	2015
71	Rafii-Tari H	15	Panorama Ultrasound for Navigation and Guidance of Epidural Anesthesia	J Ultrasound Med	2015
72	Gupta RK	15	Improving Needle Visualization by Novice Residents During an In-Plane Ultrasound Nerve Block Simulation Using an In-Plane Multiangle Needle Guide	J Ultrasound Med	2013
73	Morparia KG	14	Respiratory variation in peak aortic velocity accurately predicts fluid responsiveness in children undergoing neurosurgery under general anesthesia	Pain Med	2018
74	Beigi, P	14	Three-Dimensional Ultrasound-Guided Real-Time Midline Epidural Needle Placement with Epiguide: A Prospective Feasibility Study	J Clin Monit Comput	2017
75	Mohammadi, SS	14	Usefulness of ultrasound view of larynx in pre-anesthetic airway assessment: A comparison with Cormack-Lehane classification during direct laryngoscopy	Ultrasound Med Biol	2016
76	Gurnaney HG	14	Anesthetic management of the first pediatric bilateral hand transplant	Can J Anesth	2016
77	Jeon Y	14	Evaluation of a simplified augmented reality device for ultrasound-guided vascular access in a vascular phantom	J Clin Anesth	2014
78	Sola C	14	Ultrasound-guided tranversus abdominis plane block for herniorrhaphy in children: What is the optimal dose of levobupivacaine?	Eur J Anaesthesiol	2014
79	You-Ten	13	Practice of ultrasound-guided palpation of neck landmarks improves accuracy of external palpation of the cricothyroid membrane	Anesth Analg	2018
80	Turkstra TP	13	Preprocedural ultrasound assessment does not improve trainee performance of spinal anesthesia for obstetrical patients: a randomized controlled trial	J Clin Anesth	2017
81	Johnson AN	13	Ultrasound-guided needle technique accuracy prospective comparison of passive magnetic tracking versus unassisted echogenic needle localization	Reg Anesth Pain Med	2017
82	Przkora R	13	Evaluation of the Head-Mounted Display for Ultrasound-Guided Peripheral Nerve Blocks in Simulated Regional Anesthesia	Pain Med	2015
83	Vial F	13	Evaluating the learning curve for the transversus abdominal plane block: a prospective observational study	Can J Anesth	2015
84	Miyashita T	13	FaceTime for teaching ultrasound-guided anesthetic procedures in remote place	J Clin Monit Comput	2014
85	Kilicaslan A	13	Differences in tip visibility and nerve block parameters between two echogenic needles during a simulation study with inexperienced anesthesia trainees	J Anesth	2014
86	Meineri M	12	Canadian recommendations for training and performance in basic perioperative point-of-care ultrasound: recommendations from a consensus of Canadian anesthesiology academic centres	Can J Anesth	2021
87	Sanders JA	12	Incorporating Perioperative Point-of-Care Ultrasound as Part of the Anesthesia Residency Curriculum	J Cardiothorac Vasc Anesth	2019
88	Sappenfield JW	12	Visualization improves supraclavicular access to the subclavian vein in a mixed reality simulator	Anesth Analg	2018
89	Alkhatib M	12	Adaptive median binary patterns for fully automatic nerves tracking in ultrasound images	Comput Methods Programs Biomed	2018
90	Luftig J	12	Ultrasound-guided retroclavicular approach infraclavicular brachial plexus block for upper extremity emergency procedures	Am J Emerg Med	2017
91	Kuang Y	12	Modelling and characterisation of a ultrasound-actuated needle for improved visibility in ultrasound-guided regional anaesthesia and tissue biopsy	Ultrasonics	2016
92	Deshpande R	12	Training the anesthesiologist in point-of-care ultrasound	Int. Anesthesiol Clin	2016
93	Woodworth GE	12	Development and Validation of an Assessment of Regional Anesthesia Ultrasound Interpretation Skills	Anesth. Pain Med	2015
94	Khedkar SM	12	Ultrasound-guided ilioinguinal and iliohypogastric nerve block, a comparison with the conventional technique: An observational study	Saudi J Anaesth	2015
95	Min JY	12	Ultrasonographic assessment of optic nerve sheath diameter during pediatric laparoscopy	Ultrasound Med Biol	2015
96	Vanderwielen BA	12	Teaching sonoanatomy to anesthesia faculty and residents: Utility of hands-on gel phantom and instructional video training models	J Clin Anesth	2015
97	Niazi AU	12	The use of an online three-dimensional model improves performance in ultrasound scanning of the spine: A randomized trial	Can J Anesth	2013
98	Leviter J	11	"Full Stomach" Despite the Wait: Point-of-care Gastric Ultrasound at the Time of Procedural Sedation in the Pediatric Emergency Department	Academic Emergency Medicine,	2019
99	Petrisor C	11	Preoperative difficult airway prediction using suprahyoid and infrahyoid ultrasonography derived measurements in anesthesiology	Medical Ultrasonography	2019
100	Woodland DC	11	Routine chest X-ray is unnecessary after ultrasound-guided central venous line placement in the operating room	Journal of Critical Care	2018

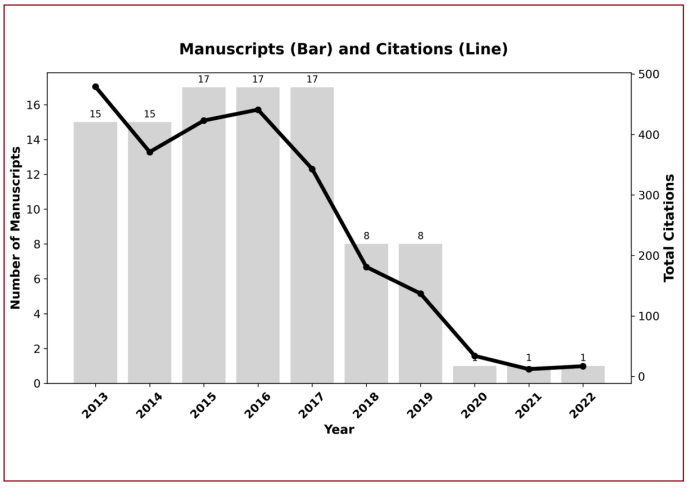

Figure 2. Publications and the cites over time

As expected, the number of articles and total citations in previous years were found to quite high. A fluctuating trend in the number of articles and total citations are also apparent in the last 10 years.

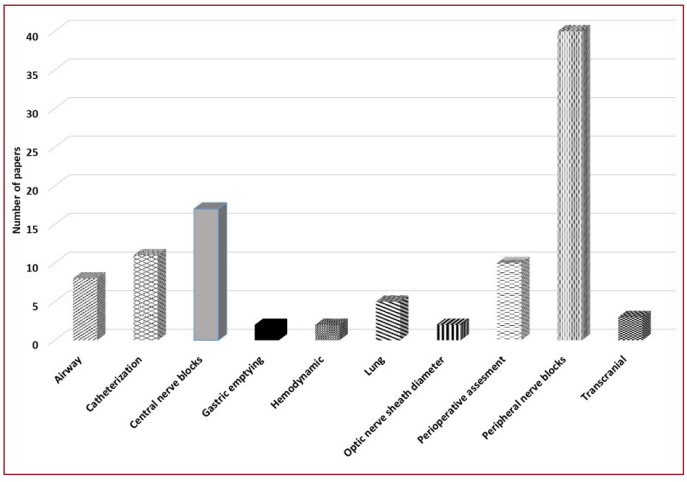

Figure 3. Evaluation of all study articles for topics

All study articles most frequently addressed the use of USG for peripheral nerve blocks, followed by central nerve blocks, catheterization, perioperative evaluation, and airway procedures (**Figure 3**). The median number of citations per year of all study articles was 2.85 (2-4.1).

The academic specialization of the first authors of 78% of the top 100 articles was anesthesiology and reanimation. In the 78 studies conducted by anesthesiology and reanimation specialists among the top 100 articles on the use of USG in anesthesiology, the most commonly addressed main topic was the use of USG for peripheral nerve blocks (n=31). On the other hand, in the six studies conducted by electrical and computer engineering experts among the top 100 articles on the use of USG in anesthesiology, the most commonly addressed main topic was the use of USG for central nerve blocks (n=5).

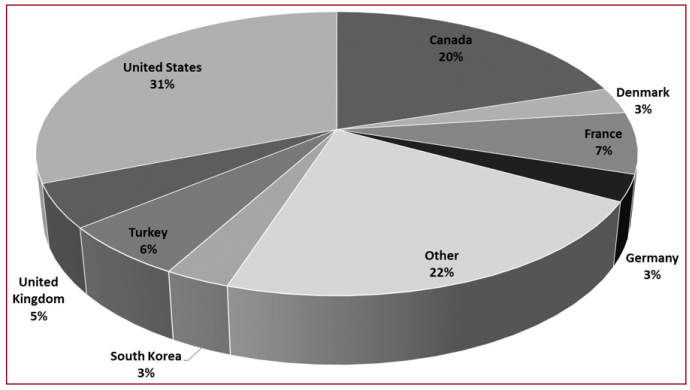

Figure 4. Country graph of the most cited articles

Additionally, it was determined that the 100 most cited articles were written from 23 different countries. It was seen that studies on these topics were mostly carried out in America (USA), followed by Canada, France, Turkey and United Kingdom (UK), respectively (**Figure 4**).

It was determined that 7 of the articles in the top 10, according to the total number of citations, also ranked among the top 10 articles in terms of the number of citations received per year (**Table 2**). The most commonly addressed main topic in the ten most cited articles per year in the field of USG and anesthesiology was the use of USG for peripheral nerve blocks (n=3), followed by the use of USG for perioperative training (n=2), preoperative fasting (n=1), gastric insufflation (n=1), arterial catheterization (n=1), transcranial function (n=1), and weaning from mechanical ventilation (n=1). It was noteworthy that Turkey was the country of origin of two of the top 10 articles with the highest number of citations per year (**Table 2**).

Among the top 10 journals with more than three of the 100 most cited articles on the use of USG in anesthesiology, it was determined that the first three journals with the highest 2021 CiteScores (10.4, 9.3, and 8.5, respectively) were Q1 and Q2 journals. Additionally, the IFs of these first three journals were 8.986, 6.627, and 5.564, respectively (**Table 3**). It was also determined that the number of publications in these quality journals with high CiteScores and IFs was lower than in other journals.

DISCUSSION

Bibliometric studies guide academicians who have just started their academic careers to areas where they can do research.[15] Before this study, there was a lack of comprehensive analysis on the most influential research in the use of ultrasonography (USG) in main anesthesiology. This bibliometric study fills that gap by identifying and analyzing the most cited articles on this topic. Our study featured 704 articles obtained as a result of the search conducted in the Scopus citation database using the keywords "ultrasonography and anesthesiology". More than half of these articles (n=482) were conducted in the last decade, that is, between 2013 and 2022. Among the all study articles on the use of USG in anesthesiology, the total

number of citations of the most cited article was 91, while the total number of citations of the least cited article was 11. The study's findings indicated that acedemicians consider the use of USG in anesthesiology interesting.

The most commonly addressed main topic in the top 100 articles in USG and anesthesiology was the use of USG for peripheral nerve blocks, followed by the use of USG for invasive procedures such as central nerve blocks, catheterization, and airway procedures.

It is noteworthy that adress in that particular study were mostly based on simulation studies. It is thought that this outcome is especially an increase parallel to the development in technology and artificial intelligence.[16,17] Since articles with older publication dates generally have higher total citation numbers, we also examined the median number of citations per year. Notably, 7 of the articles in the top 10 according to the total number of citations also ranked among the top 10 articles according to the number of citations received by year. In sum, well-designed prospective studies always attract the attention of academicians in the medical community, and the authors of such studies receive the value they deserve in world literature through the citations made to their studie.[6,8,10,18,19]

USG, a non-invasive imaging method, has recently become very popular among clinicians. In anesthesiology and reanimation departments where invasive procedures are frequently performed, using USG before surgical procedures increases the physician's success and reduces the complication rate.[1] It was determined that anesthesiologists authored 78% of the top 100 articles with the highest number of citations and that they most commonly addressed the use of USG for peripheral nerve blocks.[20,21] Notably, the physicians performing USG in the studies were not radiologists. USG imaging techniques, which were generally used only by radiologists in the past, are now widely used by anesthesiologists and other physicians. Physicians working in the fields of "anesthesiology and pain medicine" and "critical care and intensive care medicine" are especially expected to use USG when performing interventional procedures. For this reason, USG training should be given to all physicians working in anesthesiology and reanimation in our country, especially during their residency.

Table 2. The analysis of top 10 manuscript for citations per year

Citations per year	Total citations	Rank in the top 100 articles	First Author	Year	Journal	Title
17	17	53	Frykholm P	2022	IEEE Trans Biomed Eng	Pre-operative fasting in children: A guideline from the European Society of Anaesthesiology and Intensive Care
13.6	58	5	Luftig J	2018	Am J Emerg Med	Successful emergency pain control for posterior rib fractures with ultrasound-guided erector spinae plane block
11.38	91	1	Ramsingh D	2015	Anesthesiology	Impact assessment of perioperative point-of-care ultrasound training on anesthesiology residents
11.33	34	15	Dres M	2020	Anesthesiology	Usefulness of Parasternal Intercostal Muscle Ultrasound during Weaning from Mechanical Ventilation
11	77	3	Mahmood F	2016	Anesth Analg	Perioperative ultrasound training in anesthesiology: A call to action
8.5	51	8	Tiran E	2017	Ultrasound Med Biol	Transcranial Functional Ultrasound Imaging in Freely Moving Awake Mice and Anesthetized Young Rats without Contrast Agent
8.3	83	2	Marhofer D	2013	Anesthesiology	Magnetic resonance imaging analysis of the spread of local anesthetic solution after ultrasound-guided lateral thoracic paravertebral blockade: A volunteer study
7.89	71	4	Bouvet L	2014	Anesthesiology	Real-time detection of gastric insufflation related to facemask pressure-controlled ventilation using ultrasonography of the antrum and epigastric auscultation in nonparalyzed patients
7.25	29	24	Aksu C	2019	Agri	Analgesic effect of the bi-level injection erector spinae plane block after breast surgery: A randomized controlled trial
6.5	65	6	Berk D	2013	J Clin Monit Comput	Ultrasound-guided radial arterial cannulation: Long axis/in-plane versus short axis/out-of-plane approaches?

Table 3. Journals with more than three published articles from the 100 most-cited clinical studies on ultrasonography in the anesthesiology

Rank	Journal Title	Number of Manuscipt	Cite Score 2021	IF	Category/Quartile/Indexing
1	Canadian Journal of Anaesthesia	9	7.6	6.713	ANESTHESIOLOGY - SCIE(Q1)
2	Journal of Clinical Monitoring and Computing	8	3.7	1.977	ANESTHESIOLOGY - SCIE(Q4)
3	Journal of Ultrasound in Medicine	8	4.2	2.754	ACOUSTICS - SCIE(Q2) RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING - SCIE(Q3)
4	Regional Anesthesia and Pain Medicine	8	8.5	5.564	ANESTHESIOLOGY - SCIE(Q2)
5	Ultrasound in Medicine and Biology	7	5.4	3.694	ACOUSTICS - SCIE(Q1) RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING - SCIE(Q2)
6	Anesthesiology	6	10.4	8.986	ANESTHESIOLOGY - SCIE(Q1)
7	European Journal of Anaesthesiology	5	5.5	4.183	ANESTHESIOLOGY - SCIE(Q2)
8	Anesthesia and Analgesia	5	9.3	6.627	ANESTHESIOLOGY - SCIE(Q1)
9	Journal of Clinical Anesthesia	5	6.7	9.375	ANESTHESIOLOGY - SCIE(Q1)
10	Acta Anaesthesiologica Scandinavica	3	3.4	2.274	ANESTHESIOLOGY - SCIE(Q4)

The high number of citations made to an article is generally related to the proper planning and reliability of the study. Robust design of studies requires both sufficient financial budget and technical structure support. We determined that the top five countries where the top 100 articles with the highest number of citations on the use of USG in anesthesiology were conducted are economically developed and developing countries. It is gratifying that Turkey ranks fourth among these five countries. The results reveal that the majority of impactful research is authored by anesthesiologists and published in high-impact journals from developed countries. This emphasizes the importance of financial and technological support in producing high-quality studies.

Notably, 80% of the top 10 journals with more than three of the top 100 articles on the use of USG in anesthesiology were Q1 and Q2 journals and generally had a high IF. Researchers select the journals to publish their articles while designing their studies and during the manuscript's writing according to the journals' reliability and IF. Considering how difficult and laborious it is to publish articles in high-quality journals, there is no doubt that there is more trust in articles published in such journals.

The Web of Science (WOS) database provides only citations of its own journals. Additionally, the citations are detected late, approximately 1 year later. However, the Scopus database is broder as it includes open access and peer-reviewed journals. It provides wider access to readers. For this reason, this study relied solely on the Scopus database, which may have led to the exclusion of relevant articles indexed elsewhere. Citation counts can vary between databases, and this limitation might affect the comprehensiveness of the analysis. Additionally, while citation metrics are valuable, they do not fully capture an article's scientific contribution or clinical impact.

CONCLUSION

This bibliometric analysis highlights the growing importance of ultrasonography in anesthesiology, particularly for nerve blocks and vascular procedures. The most cited research, primarily authored by anesthesiologists from developed countries, underscores the influence of financial and technological resources on the quality and impact of studies. These findings emphasize the critical role of ultrasonography in enhancing clinical practice and improving patient outcomes.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of **XXXXXXXXXXXXXXXX** Ethics Committee (Date: **XXXXXXXXXX**, Decision No: 2017/99).

Informed Consent: Informed consent was obtained from the families of all children participating in the study.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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