

# The Twenty-Five Most Cited Articles About Adductor Canal Block: A Bibliometric Analysis from 1980 to 2022

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**Introduction:** Loco-regional anesthesia role is increasingly important in surgery, especially in postoperative pain control. Using ultrasound-guided techniques has made the loco-regional approach increasingly safe and manageable, guaranteeing excellent analgesic results and patient compliance. This bibliometric research aimed to identify the most influential papers on the adductor canal blocks and outline their characteristics.

**Methods:** All articles published from 1980 to 2022 were included in the Web of Science, PubMed, and Scopus databases and found using the keywords "Adductor canal block" or "Saphenous nerve block" or "Peripheral nerve block" or "Hunter canal block" or "Subsartorial canal block" or "ACB" or "Knee" or "TKR" or "TKA" or "Analgesia" or "Arthroplasty" or "Replacement" in the title section had bibliometric analysis performed. The first 25 papers were selected and analyzed by the number of citations. The correlation between numerical variables was evaluated using the Pearson Correlation coefficient.

**Results:** Literature screening found 252 publications. One hundred ten were only about the adductor canal block. Of these, 25 articles were selected for our bibliometric study, published in 8 different journals and with a total number of citations equal to 1.457. "Regional Anesthesia and pain medicine" journal – with 9 articles – was the one that produced the most. There was a significant strong correlation between the n. of citations and the citation rate ( $R = 0.84$ ,  $p < 0.001$ ).

**Conclusion:** The purpose of this study is to be a guide on regional anesthesia and, particularly, on adductor canal block, making the most effective as well as the most cited articles available to anesthesiologists or other researchers interested in this topic.

**Keywords:** adductor canal block, peripheral nerve block, bibliometric, TKA, TKR, analgesia

## Introduction

Locoregional anesthesia, especially postoperative analgesia, is increasingly being performed for surgeries executed under both neuraxial and general anesthesia.<sup>1</sup> In the postoperative period, neuraxial anesthesia has a lower risk of complications and mortality than general anesthesia.<sup>2</sup> Any type of surgery is performed, locoregional anesthesia – with an ultrasound-guided technique – results in excellent analgesia and reduced complications.<sup>1–4</sup> Total knee replacement surgery for orthopedic surgery causes postoperative pain that is difficult to manage and, in this case, a continuous epidural block is still an effective anesthesiologic approach. However, this approach cannot be performed in all patients because of coagulopathies and technique difficulty.<sup>3–5</sup> Ultrasound-guided locoregional anesthesia is a more selective and patient-tailored method that consists of a sensory block of the saphenous nerve in Hunter's canal.<sup>6</sup> Many anesthesiologists perform this type of technique but the difficulty is often finding the

right sources to understand how to approach it as best they can from both anatomical and procedural points of view.

Adductor canal block represents a viable alternative regarding postoperative analgesia in knee surgery.<sup>6</sup> The adductor canal is an aponeurotic structure located in the medial part of the thigh that extends from the apex of Scarpa's triangle to the adductor hiatus. The femoral vessels and saphenous nerve run through it.<sup>7</sup> There are well-defined ultrasound findings to establish the origin of Hunter's canal that allow us to avoid motor block involvement of the vastus medialis muscle.<sup>8</sup> Therefore, the adductor canal block is a purely sensory peripheral nerve block. As such, it is an effective technique for fast-track surgery protocols because it could provide some benefits: improved mobility, reduced risk of falls, and significantly reduced hospitalization time.<sup>9</sup>

In recent times, there has been an increasing trend of bibliometric studies performed in healthcare.<sup>10–15</sup> Employing quantitative measures, bibliometric analyses aim to examine the trend in publications about a specific topic, defining the characteristics of most influential manuscripts and identifying potential correlations regarding the type of study, its quality, its level of evidence, etc.<sup>10–13</sup> Bibliometric studies are important tools in evaluating research performance and identifying influential papers in a particular field. By comparing changes in the citation trends of published papers, it is possible to better understand the current research situation and determine the direction for future efforts.<sup>14,15</sup>

The purpose of this study is to provide anesthesiologists with a collection of articles related to adductor canal block and to summarize what has been shown so far by the most influential papers produced on this topic.

## Materials and Methods

Literature scanning was performed with the Web of Science (WoS: by Clavariate Analytics), PubMed and Scopus databases selected anesthesiology journals (access date: 03.01.2022). All articles containing the search keywords in the "Title" section, published from 1980 to 2022 in the WoS, PubMed, and Scopus databases, had performed bibliometric analysis. The search keywords used the following codes: "Adductor canal block" or "Saphenous nerve block" or "Peripheral nerve block" or "Hunter canal block" or "Subsartorial canal block" or "ACB" or "Knee" or "TKR" or "TKA" or "Analgesia" or "Arthroplasty" or "Replacement".

The research was not limited only to English-language articles. Articles comparing saphenous nerve block in Hunter's canal with other types of techniques were kept out of the exclusion criteria because there could be a citation bias (Figure 1).

The research was performed by two authors independently of each other.

About the articles concerning only the adductor canal block, we researched the following information: year of publication, authors, journal of publication and number of citations, geographic area, study type and citation density, and subject.

Data were reported as mean value, standard deviation, and range values (minimum and maximum). The correlation between variables was assessed using the Pearson Correlation Coefficient. The correlation was considered strong if the coefficient value lay between  $\pm 0.50$  and  $\pm 1$ , moderate between  $\pm 0.30$  and  $\pm 0.49$ , and poor below  $\pm 0.29$ . The statistical analysis was performed using Stata (Version 16).

The outcomes of this study were the number of citations and the citation rate.

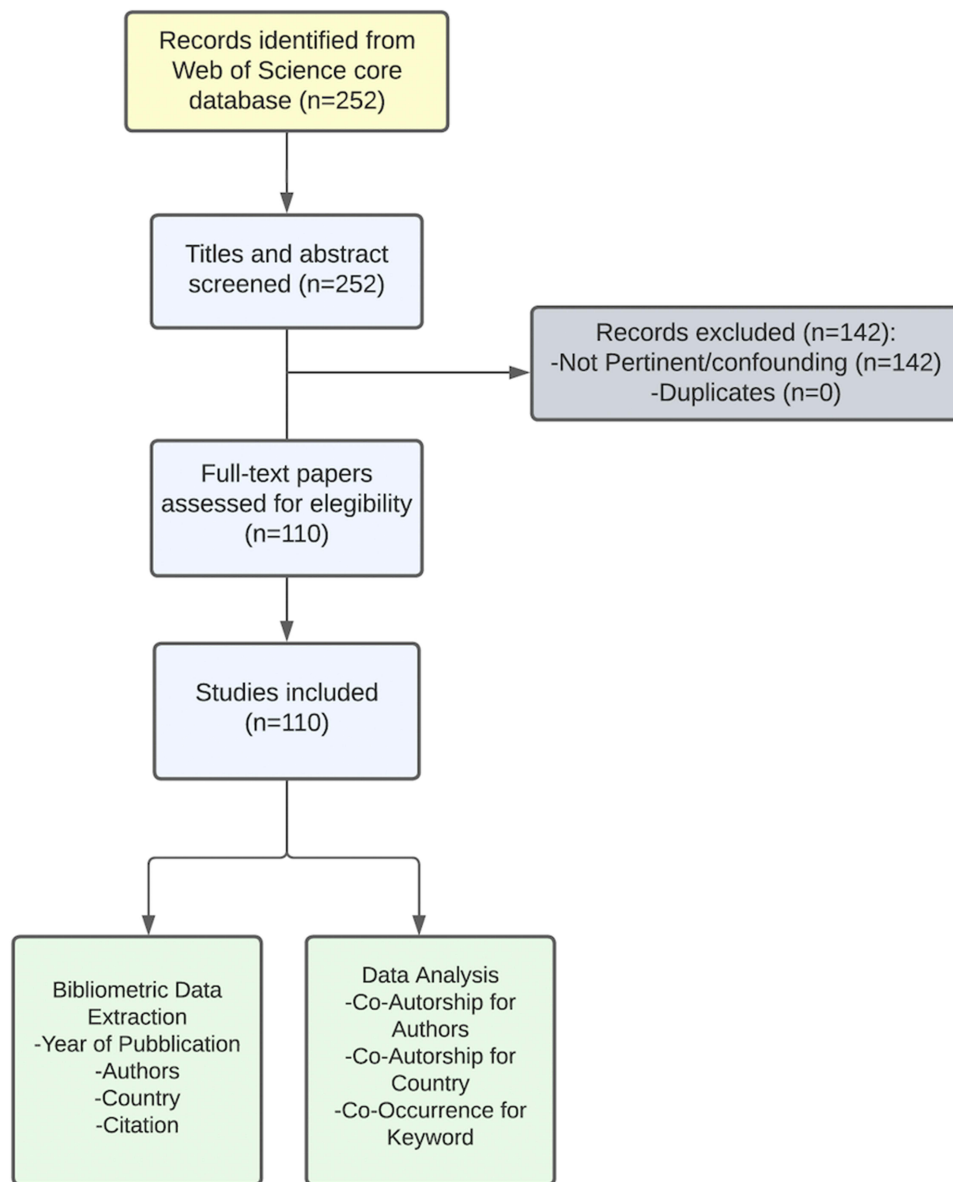
## Results

Literature screening found a total of 252 published items. One hundred and ten of them were focused on the adductor canal block. These were published from 1993 to 2022 with a peak of interest in the topic occurring in 2014 (Figure 2). The active journals produced most of the articles as shown in Figure 3.

The top 10 authors published most papers for adductor canal block and the number of citations appeared in Table 1.

The 25 most-cited papers have been depicted in Table 2.<sup>6–8,16–37</sup>

The research only performed a bibliometric analysis of the 25 published articles.<sup>6–8,16–37</sup>



**Figure 1** Flowchart of the study.

It was selected because the citation density of the other found articles was very low. There were a total of 1.457 citations of the 25 articles, with an average citation per item of 58.28. The keywords of the 25 most cited articles are shown in [Figure 4](#).

The 25 articles were published in 8 journals.<sup>6-8,16-37</sup> Among these journals, “Regional Anesthesia and pain medicine” - with 9 articles – was the one that produced the most ([Figure 5](#)).<sup>7,8,31-37</sup>

The impact factors and quartile of the journals which were the most interested in the topic are shown in [Table 3](#). [Figure 6](#) shows that most of these journals were in the first quartile.

The publication year of the 25 most cited articles ranges from 1993 to 2017.<sup>6-8,16-37</sup>

Denmark, the United States, and Canada were respectively the active countries that produced the most ([Figure 7](#)).<sup>6-8,16-22,24-33,35-37</sup>

Nine articles concerned only with analgesia,<sup>6,16-18,20,25,29,30,32</sup> 4 only with anatomy,<sup>31,33,36,37</sup>

1 only with ultrasonography,<sup>26</sup> 2 with ultrasonographic anatomy,<sup>19,23</sup> 4 with analgesia and ultrasonography,<sup>7,8,21,28</sup> 3 with analgesia and anatomy,<sup>27,34,35</sup> 2 with analgesia and ultrasonographic anatomy.<sup>22,24</sup>

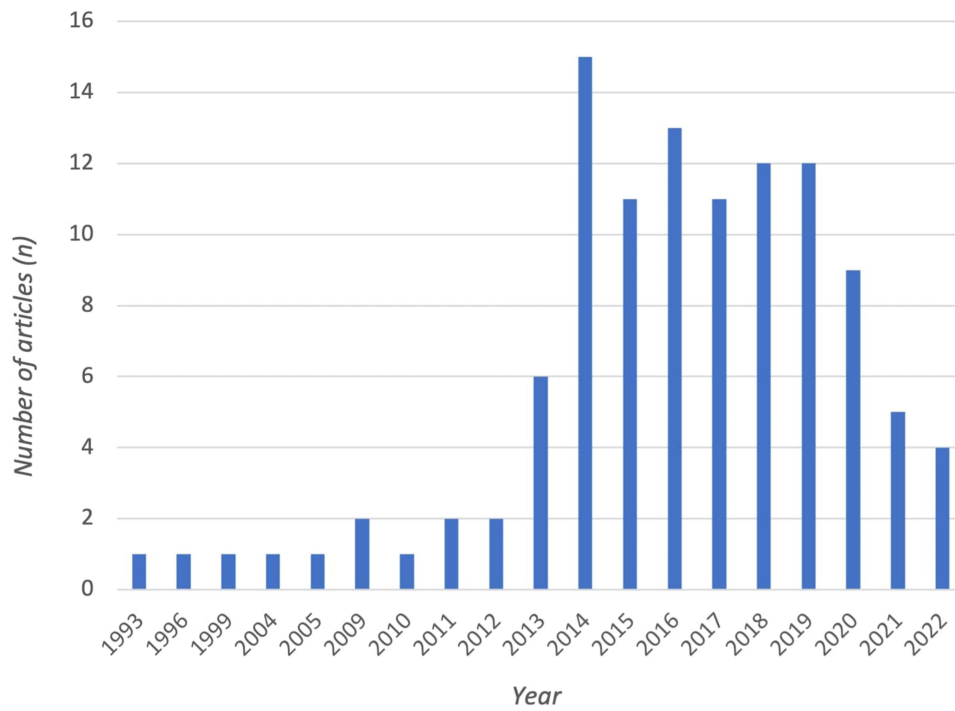


Figure 2 Number of publications by years on adductor canal block.

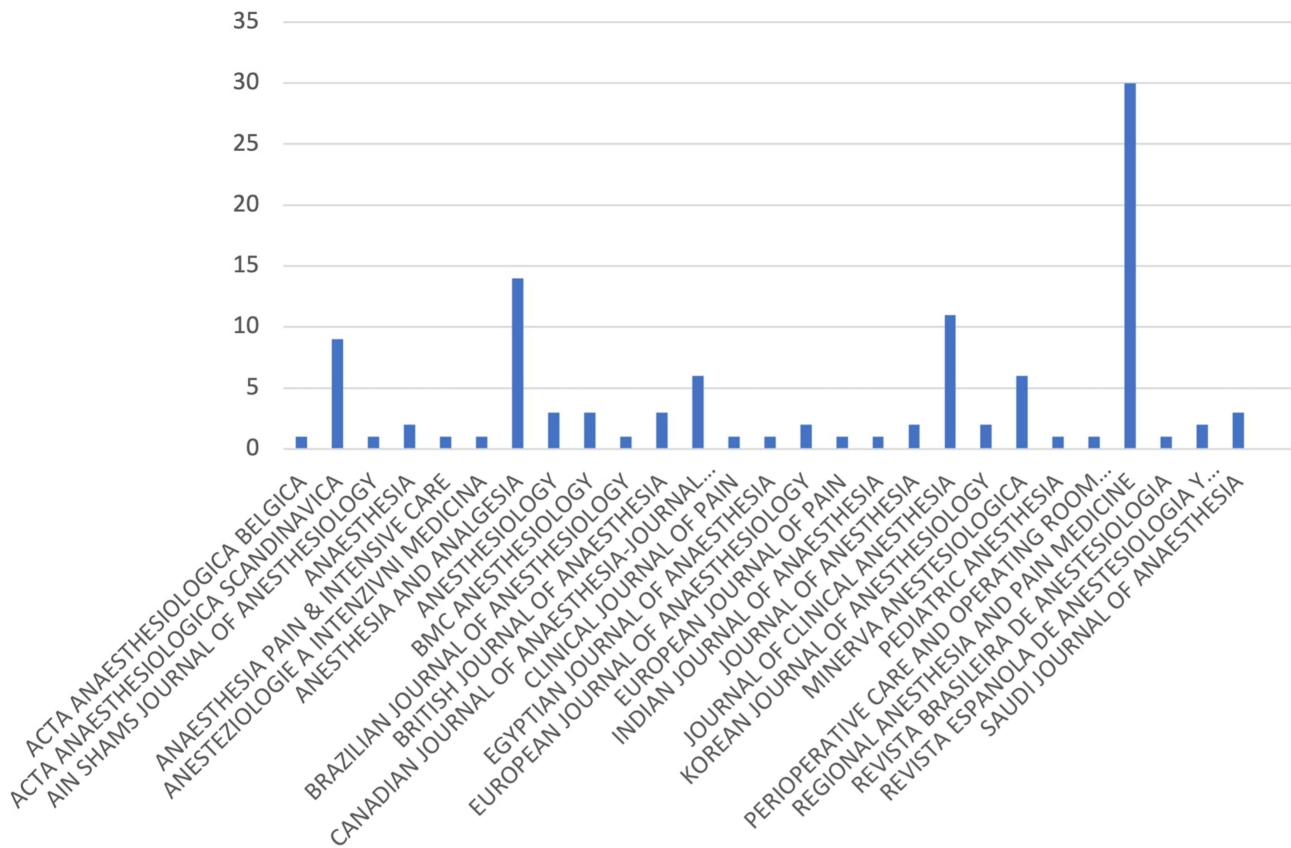


Figure 3 Active journals on adductor canal block.

**Table 1** Authors with Top-10 Number of Papers Included in the 110 Most-Cited

Author	First	Co-Author	Last	Total	Total Citations
Dahl, Jorgen Berg	0	2	11	13	628
Jaeger, Pia	4	7	0	11	549
Grevstad, Ulrik	2	4	1	7	196
Auyong, David B.	0	4	2	6	204
Mathiesen, Ole	0	5	1	6	390
Hanson, Neil A.	3	1	2	6	204
Lund, Jorgen	1	3	0	4	357
Jenstrup, M. T.	1	3	0	4	357
Borglum, Jens	0	1	3	4	133
Bendtsen, Thomas Fichtner	3	0	1	4	133

We found a strong correlation between the n. of citations of a study and its citation rate ( $R = 0.84$ ,  $p < 0.001$ ) (Table 4 and Figure 8). Conversely, no correlation was identified between the year of publication and the number of citations of a study ( $p = 0.62$ ) nor its citation rate ( $p = 0.15$ ). No correlation between the level of evidence and the number of citations ( $p = 0.23$ ) nor the citation rate ( $p = 0.26$ ) was found.

## Discussion

According to our research findings, a significant increasing trend was found for the number of articles about the topic of adductor canal block with a peak of interest occurring in 2014.<sup>20,21,25,32,35,37</sup>

When the article distribution by country was investigated, it was observed that Denmark, the USA, and Canada were respectively the active countries that produced the most.<sup>6-8,16-22,24-33,35-37</sup>

Our research highlighted the main topics on the adductor canal: anatomy of the adductor canal, ultrasound-anatomy, ultrasound-guided approach for ACB, and postoperative analgesia.<sup>6-8,16-37</sup>

Seventy-two percent of the examined articles were concerned with analgesia: they focused on various anesthetic mixtures and the analgesic efficacy of the block in knee surgery.<sup>6-8,16-18,20-22,24,25,27-30,32,34,35</sup>

None of the 25 most cited papers focused on the comparison of the single-shot technique versus continuous infusion with a perineural catheter, the devices to be used, or the incidence of major and minor complications. In addition, it was noted that in the 25 most cited studies there were few with high scientific evidence such as systematic reviews or meta-analysis.

In the past, postoperative analgesia was mostly peridural, whereas in recent years peripheral regional echo-guided loco-regional is increasingly chosen especially the adductor canal block in knee surgery.<sup>3,4</sup> Probably, the increased incidence of echo-guided loco-regional anesthesia, compared with continuous neuraxial anesthesia, is explained by the easiest reproducibility of the technique. Also, continuous peridural analgesia is often not feasible in all patients due to a lack of clinical skills or because of an expected technique that is difficult to perform.

Postoperative analgesia by adductor canal block, compared with neuraxial analgesia, allows a lower incidence of the motor block because the saphenous nerve is purely sensory and consequently allows early mobilization.<sup>9</sup> Loco-regional anesthesia has a cost impact compared with general anesthesia.<sup>38</sup> It must be remembered that sensory blocks, as well as fascia blocks, are not without complications.<sup>39</sup> In patients undergoing primary total knee implantation, a single-shot block in the context of multimodal analgesia is also optimal for pain management

**Table 2 25 Most Cited Articles About ACB**

Article Title	Journal	First Author-Last Author	Publication Year	Times Cited	Country	Citation Density	Study Type
Effects of Adductor-Canal-Blockade on pain and ambulation after total knee arthroplasty: a randomized study <sup>16</sup>	Acta anaesthesiologica Scandinavica	Jenstrup, M. T.; Dahl, J. B.	2012	187	Denmark	20,8	Randomized Controlled Trial
Continuous adductor-canal-blockade for adjuvant post-operative analgesia after major knee surgery: preliminary results <sup>17</sup>	Acta anaesthesiologica Scandinavica	Lund, J.; Dahl, J. B.	2011	135	Denmark	13,5	Case series
Effect of adductor-canal-blockade on established, severe post-operative pain after total knee arthroplasty: a randomised study <sup>18</sup>	Acta anaesthesiologica Scandinavica	Jaeger, P.; Dahl, J. B.	2012	87	Denmark	9,7	Randomized Controlled Trial
The spread of injectate during saphenous nerve block at the adductor canal: a cadaver study <sup>19</sup>	Acta anaesthesiologica Scandinavica	Andersen, H. L; Tranum-Jensen, J.	2015	52	Denmark	8,7	Observational cadaver study
Delayed quadriceps weakness after continuous adductor canal block for total knee arthroplasty: a case report <sup>20</sup>	Acta anaesthesiologica Scandinavica	Veal, Christopher; Strodbeck, Wyndam	2014	42	USA	6	Case Reports
Continuous Ultrasound-Guided Adductor Canal Block for Total Knee Arthroplasty: A Randomized, Double-Blind Trial <sup>21</sup>	Anesthesia and analgesia	Hanson, Neil A.; Auyong, David B.	2014	91	USA	13	Randomized Controlled Trial
A Comparison of Ultrasound-Guided and Landmark-Based Approaches to Saphenous Nerve Blockade: A Prospective, Controlled, Blinded, Crossover Trial <sup>22</sup>	Anesthesia and analgesia	Kent, Michael L.; Corey, John M.	2013	27	USA	3,4	Prospective Study
Distribution of Injectate and Sensory-Motor Blockade After Adductor Canal Block <sup>23</sup>	Anesthesia and analgesia	Gautier, Philippe E.; Vandepitte, Catherine	2016	25	Belgium	5	Observational study
Comparison of the different approaches to saphenous nerve block <sup>24</sup>	Anesthesiology	Benzon, HT; Calimaran, A	2005	33	USA	2,1	Prospective Comparative Study
Effect of adductor canal block on pain in patients with severe pain after total knee arthroplasty: a randomized study with individual patient analysis <sup>25</sup>	British journal of anaesthesia	Grevstad, U.; Dahl, J. B.	2014	39	Denmark	5,6	Randomized Controlled Trial
Optimal volume of local anaesthetic for adductor canal block: using the continual reassessment method to estimate ED95 <sup>26</sup>	British journal of anaesthesia	Jaeger, P.; Dahl, J. B.	2015	26	Denmark	4,3	Clinical Trial
Transarterial approach for saphenous nerve block <sup>27</sup>	Canadian journal of anaesthesia-journal canadien d'anesthesie	VANDERWAL, M; YIP, RW	1993	56	Canada	2	Randomized Controlled Trial

Efficacy of an ultrasound-guided subsartorial approach to saphenous nerve block: a case series <sup>28</sup>	Canadian journal of anaesthesia-journal canadien d'anesthesie	Tsai, Phil B.; Julka, Inderjeet S.	2010	28	USA	2,6	Retrospective case series
Ultrasound-guided adductor canal block for arthroscopic medial meniscectomy: a randomized, double-blind trial <sup>29</sup>	Canadian journal of anesthesia-journal canadien d'anesthesie	Hanson, Neil A.; Slee, April E.	2013	39	USA	4,3	Randomized Controlled Trial
Analgesic efficacy of ultrasound-guided adductor canal blockade after arthroscopic anterior cruciate ligament reconstruction A randomised controlled trial <sup>30</sup>	European journal of anaesthesiology	Espelund, Malene; Dahl, Jorgen B.	2013	46	Denmark	5,8	Randomized Controlled Trial
Adductor canal block for knee surgical procedures: review article <sup>6</sup>	Journal of clinical anesthesia	Vora, Maulin U.; Grant, Stuart A.	2016	25	USA	5	Review
Feasibility and Efficacy of Ultrasound-Guided Block of the Saphenous Nerve in the Adductor Canal <sup>8</sup>	Regional anesthesia and pain medicine	Manickam, Baskar; Ramlogan, Reva	2009	109	Canada	9,1	Observational study
The Nerves of the Adductor Canal and the Innervation of the Knee An Anatomic Study <sup>31</sup>	Regional anesthesia and pain medicine	Burkett-St Laurant, David; Perlas, Anahi	2016	102	Canada	20,4	Randomized Controlled Trial
Adductor Canal Block Can Result in Motor Block of the Quadriceps Muscle <sup>32</sup>	Regional anesthesia and pain medicine	Chen, Junping; Resta-Flarer, Francesco	2014	61	USA	8,7	Case Reports
Anatomic Basis to the Ultrasound-Guided Approach for Saphenous Nerve Blockade <sup>33</sup>	Regional anesthesia and pain medicine	Horn, Jean-Louis; Benninger, Brion	2009	58	USA	4,8	Cadaveric study
Anatomy and Clinical Implications of the Ultrasound-Guided Subsartorial Saphenous Nerve Block <sup>34</sup>	Regional anesthesia and pain medicine	Saranteas, Theodosios; Kostopanagiotou, Georgia	2011	56	Greece	5,6	Retrospective case series
Defining the Location of the Adductor Canal Using Ultrasound <sup>35</sup>	Regional anesthesia and pain medicine	Wong, Wan Yi; Bendtsen, Thomas Fichtner	2017	49	Denmark	12,3	Randomized Controlled Trial
Defining Adductor Canal Block <sup>36</sup>	Regional anesthesia and pain medicine	Bendtsen, Thomas Fichtner; Borglum, Jens	2014	33	Denmark	4,7	Letter
Basic Topography of the Saphenous Nerve in the Femoral Triangle and the Adductor Canal <sup>7</sup>	Regional anesthesia and pain medicine	Bendtsen, Thomas Fichtner; Borglum, Jens	2015	26	Canada	4,3	Letter
Redefining the Adductor Canal Block <sup>37</sup>	Regional anesthesia and pain medicine	Bendtsen, Thomas Fichtner; Borglum, Jens	2014	25	Denmark	3,6	Letter

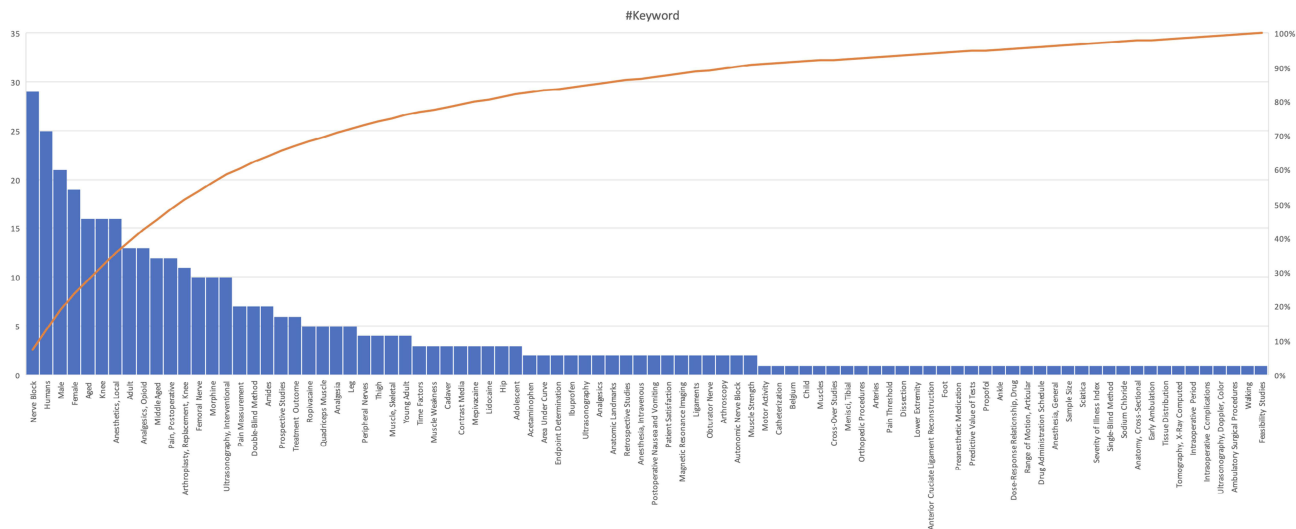


Figure 4 The keywords of the 25 most cited articles.

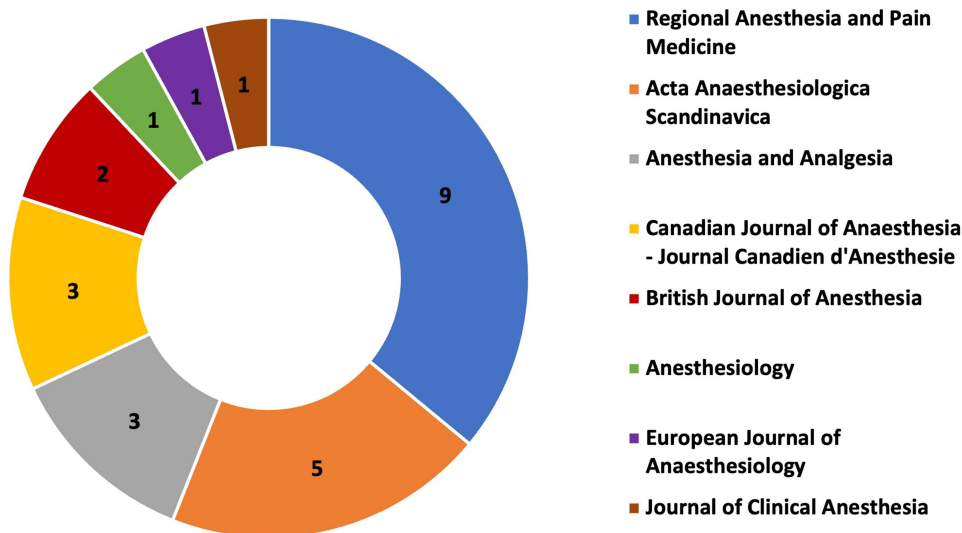


Figure 5 Active journals in 25 most cited articles.

in the first 24 hours after surgery.<sup>16</sup> Neuromuscular diseases, such as multiple sclerosis, are not contraindications to loco-regional anesthesia.<sup>40,41</sup>

The adductor canal block can be performed as a single-shot puncture, resulting in temporary analgesia depending on the concentration of local anesthetic in the mixture or it can be performed with a continuous infusion by catheter placement in the perineural site.<sup>42</sup>

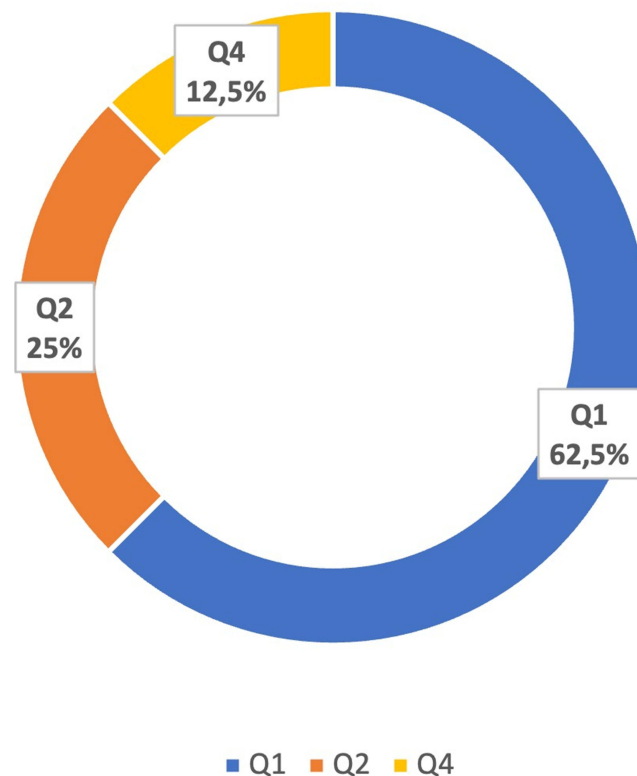
Antonio Coviello et al, in this retrospective single-center study, compared different positions of the catheter tip concerning the saphenous nerve in terms of efficacy and complications, concluding that positioning the catheter tip posteriorly to the saphenous nerve may lead to greater postoperative analgesia and reduce the risk of pump block compared to placing the catheter tip anteriorly to the nerve.<sup>43</sup>

**Table 3** The IF of the Journals About 25 Most Cited Articles

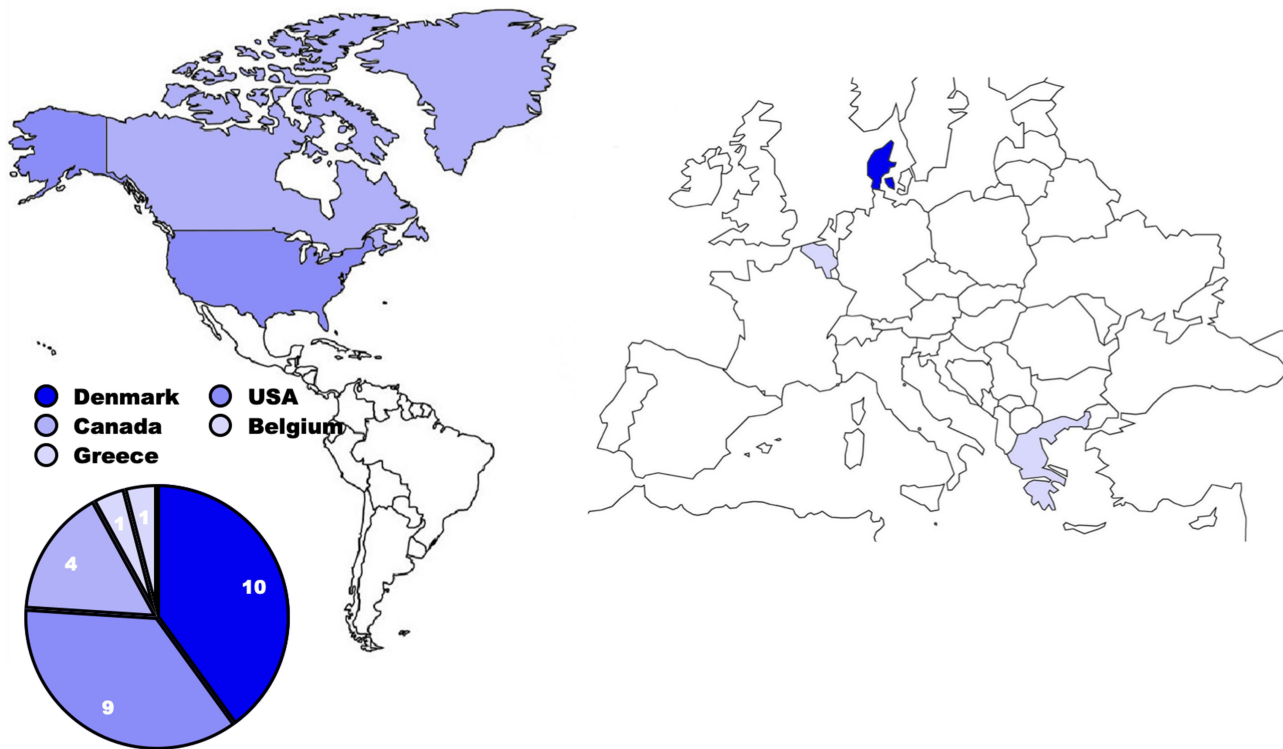
Journal	Impact Factor	Quartile
Acta anaesthesiologica Scandinavica	2.274	Q4
Anesthesia and analgesia	6.627	Q1
Anesthesiology	8.986	Q1
British journal of anaesthesia	11.719	Q1
Canadian journal of anaesthesia-journal canadien d'anesthesie	6.713	Q1
European journal of anaesthesiology	4.183	Q2
Journal of clinical anesthesia	9.375	Q1
Regional anesthesia and pain medicine	5.564	Q2

In this human cadaver study, Pierre Goffin et al observed that after injection of 20 mL of local anesthetic, it diffused through the interfascial planes into the popliteal fossa, hypothesizing that this volume of anesthetic could also determine analgesia of the posterior part of the knee.<sup>44</sup>

Scientific articles that help best approach the technique both with anatomical indications on cadavers and especially with information on ultrasound-anatomy and the type of drug mixtures to be used are increasingly available in the literature and can be helpful to those using to these techniques. The analysis of the appropriate



**Figure 6** Quartile analysis of the 25 most cited articles.  
**Abbreviation:** Q, Quartile.



**Figure 7** The distribution of the 25 most cited articles according to countries in the world.

literature is essential and time-consuming to find the appropriate information. This is the reason why this study was conducted.

A limitation of our study is that there are only articles published in anesthesia journals. Additionally, in situations where more than one database is used for bibliometric studies analyzing large numbers of articles, the inclusion of the same article more than once in the analysis may affect the reliability of the results.

We can do some suggestions for future research. A bibliometric study is primarily intended to offer research suggestions. Outcome analysis is a key aspect of the research. The most important gap to be addressed is the standardization of methods and the definition of protocols, this gap is shown in other analgesic technique areas.<sup>45</sup> In other words, the lack of uniform application criteria can limit the judgment on the effectiveness of the technique. Although adductor canal block is a simple intervention, practitioners must customize their treatment strategy based on several variables. Therefore, good practice guidelines are needed. Finally, the absence of an analysis of adverse events is a serious gap.

**Table 4** Correlation Between the N. of Citations and the Citation Rate

Variable	Observed Studies	Mean	Standard Deviation	Min	Max
N. of citations	25	58.28	40.16479	25	187
Citation rate	25	7.412	5.118701	2	20.8

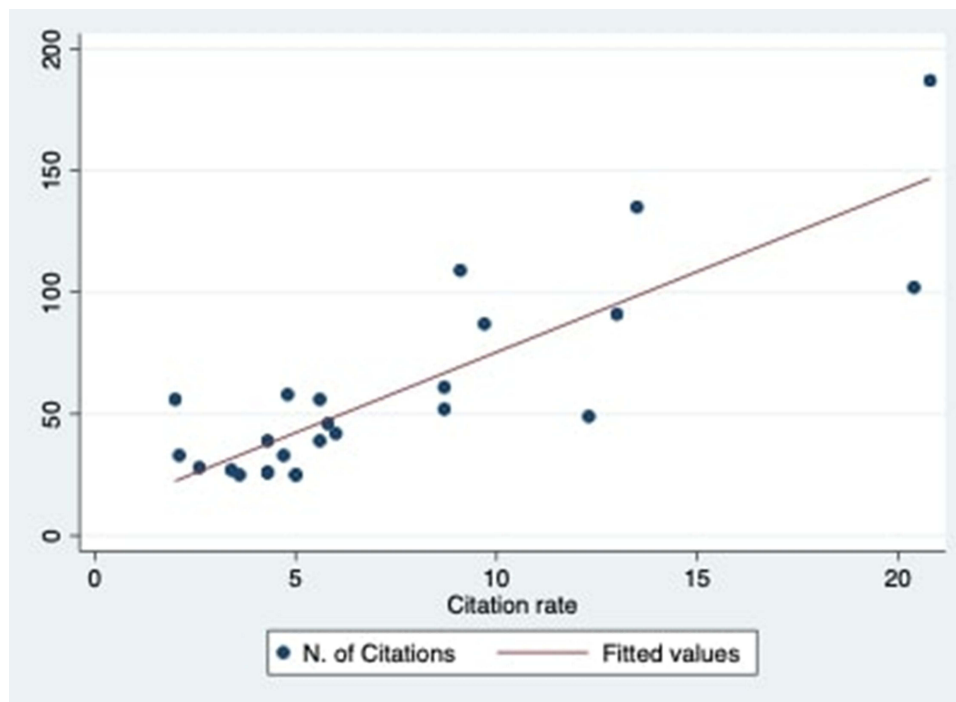


Figure 8 Scatterplot n. of citations/citation rate.

## Conclusion

This bibliometric analysis showed that the produced literature on the topic is progressively increasing. There were no meta-analysis and few systemic reviews among the 25 most cited papers on the topic. This summary will allow an anesthesiologist or other researcher to see the most effective articles, most cited articles, and perhaps the articles that should initially be read about this topic. Observing which journals produce the most articles in this scope and which journals contain articles receiving the most citations will allow easy assessment of current data. A bibliometric analysis is a profitable opportunity for highlighting potential gaps in the literature. Concerning adductor canal block, more studies with a high level of scientific evidence need to be produced. On the other hand, there is the necessity to increase clinical research as well as scientific collaboration between researcher teams and institutions from different countries.

## Data Sharing Statement

Research data supporting this publication are available from the Web of Science, PubMed, and Scopus. All charts and analysis in this article are derived based on these original data.

## Ethical Approval

The authors confirmed that no ethical approval is required.

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## Author Contributions

- A. Coviello: Conceptualization, Reviewing, and Writing
- C. Iacovazzo: Reviewing and Writing
- D. Cirillo: Conceptualization, Writing
- P. Diglio: Data curation, Writing

A. Bernasconi: Acquisition data, Writing

Anella D'Abrunzo: Analysis and/or interpretation of data, Writing

M.S. Barone: Study design, Writing

C. Posillipo: Drafting, Execution, Writing

M. Vargas: Choice of the journal to which the article will be submitted and Writing

G. Servillo: Critically reviewed the article and Writing

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors report no conflicts of interest in this work.

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