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Fifty Years of Cervical Myelopathy Research: Results from a Bibliometric Analysis

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We performed bibliometric analysis of the research papers published on clinical cervical spondylotic myelopathy (CSM) in the last 50 years. We extracted bibliometric data from Scopus and PubMed from 1970 to 2020 pertaining to clinical studies of CSM. The predominant journals, top cited articles, authors, and countries were identified using performance analysis. Science mapping was also performed to reveal the emerging trends, and conceptual and social structures of the authors and countries. Bibliometrix R-package was deployed for the study. The total numbers of clinical studies available in PubMed and Scopus were 1,302 and 3,470, respectively. The most cited article was published by Hilibrand AS, as observed in Scopus. Regarding the conceptual structure of the research, two main research themes were identified, one involving symptomatology, scientific-scale-based objective evaluation of symptoms, and surgical removal of the offending culprit, while the other was based on patho-etiology, relevant diagnostic modalities, and the surgery commonly performed for CSM. In terms of emerging trends, in recent times there is an increasing trend of scale-based objective evaluations, along with investigations of advanced nonoperative management. The United States is the most productive country, whereas Canada tops the list for inter-country collaboration. The trend of research showed a shift toward noninvasive procedures.

Keywords: Bibliometrics; Cervical spondylotic myelopathy; Conceptual structure; Performance mapping; Science mapping

Introduction

Cervical spondylotic myelopathy (CSM) is a progressive degenerative disease of the cervical spine leading to static and repeated dynamic cord compression. It is the most common cause of spinal cord dysfunction in quinquagenarians and beyond. It is also the predominant cause of atraumatic spinal cord injury [1]. The management, research, and overall understanding of CSM continue to evolve as our understanding of the disease, mechanisms, pathogenesis, and treatment options improves.

In the international literature, magnetic resonance imaging (MRI)-based population studies have revealed that more than 85% of adults aged above 60 years have severe degeneration of at least one cervical level. Most patients are usually asymptomatic because of the lower incidence of radiculopathy and myelopathy and the average age at diagnosis is about 64 years. CSM is more prevalent in men than in women (ratio of 2.7:1) [2]. A door-to-door survey in a Sicilian municipality found the prevalence of cervical spondylotic radiculopathy to be 3.5 per 1,000 population, with a peak in the 50–59-year-old age group [3]. Nouri

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et al. [4] performed a narrative review and concluded that the incidence and prevalence of CSM were about 41 and 605, respectively, per 1,000,000 population in North America. Unfortunately, we were unable to find studies documenting the incidence and prevalence of CSM in different parts of Southeast Asia.

The etiopathogenesis of CSM is multifactorial, involving static factors like congenital cervical spine stenosis, disk protrusion, vertebral deformity, osteophytes, hypertrophy of ligamentum flavum, and ossification of posterior longitudinal ligament causing cord compression, along with dynamic factors such as hypermobility of the spinal cord leading to repetitive trauma [1].

The presentation of CSM is variable and involves sensory, motor, and autonomous systems to different extents among affected individuals [4]. The symptoms and signs are usually insidious in onset and may involve loss of hand dexterity, weakness of upper limb and lower limb musculature, gait disorder, urinary symptoms, neck pain, arm pain, decrease in mobility of the neck, paresthesia in arm, and loss of touch and proprioception [4]. The signs associated with myelopathic changes may be resolved after successful surgery.

The diagnosis of CSM is based predominantly on clinical assessment and MRI findings [5]. Surgery for CSM involves decompression of the spinal cord by expansion of the spinal canal by an anterior, posterior, or combined approach [6,7]. The anterior approach includes anterior cervical discectomy or corpectomy along with fusion, and cervical arthroplasty. The posterior approach includes laminoplasty or a laminectomy with or without fusion [5].

Conservative management, which includes immobilization of the neck using a cervical collar, lifestyle modification, and pharmacological interventions, among others, has little role in stopping disease progression or reversing it [5].

Bibliometric analysis is an exploratory method to identify research directions, clarify the evolution of a research field, and identify collaborative nodes in terms of institutions, countries, and primary initiatives that have driven the research using statistical and modeling techniques [8-10]. It also provides useful cues to funding agencies to identify priority areas and help in directing grants. Bibliometric methods can mostly be divided into two groups: evaluative and relational [11-13]. In evaluative methods, the impact of research work, authors, and so on is evaluated using productivity measures (e.g., the number of papers published per year), impact metrics (e.g., the number of citations per year), and hybrid metrics (e.g., h-index). In relational techniques, the relationships among various entities such as authors, publications, countries, and research fields are explored. Recently, Sinha et al. [14] analyzed the top 100 publications in the field of cervical myelopathy based on the number of citations. They concentrated their efforts on the most influential and highly cited articles. Our study on clinical studies of CSM was established to collect, compile, and analyze the last 50 years of data and research based on scientific bibliometric analysis. We employed evaluative and relational methods for mapping the overview of the evolution of the literature and recommendations on this entity, along with identifying the top cited papers, the predominant journals, and the networks of countries, institutions, collaborators, and authors, as well as various similar parameters.

Materials and Methods

1. Data extraction

In this work, we focused on clinical studies conducted in the past 50 years for CSM as it is primarily a clinico-radiological diagnosis with clinical manifestations. We analyzed two different sources of bibliometric information: Scopus and PubMed. The search queries were designed to retrieve papers on clinical studies related to CSM. Terms including "cervical spondylosis," "cervical spondylotic myelopathy," "cervical myelopathy," "cervical degenerative disk disease," and "cervical prolapsed intervertebral disc" were searched for in the abstract, title, and keywords to retrieve documents related to CSM. From this, only the documents pertaining to clinical studies were included for further analysis. For this purpose, the filter "article type" was used in PubMed. For Scopus, the articles were limited by using keywords related to clinical studies (Table 1). Further, the English articles from 1970 to 2020 were extracted for our analysis. The files were downloaded in Bibtex format. See Supplement 1 for the search queries.

2. Data analysis

The extracted data were analyzed using RStudio (RStudio, Boston, MA, USA) and bibliometrix R-package (University of Naples Federico II, Naples, Italy) [15]. The bibliometric data consisted of information such as authors' names, article type, source (where it was published, e.g.,

Table 1. Inclusion criteria

	PubMed	Scopus
Clinical studies	Where publication type=Clinical Trial OR Clinical Study OR Adaptive Clinical Trial OR Clinical Trial Protocol OR Clinical Trial, Phase I OR Clinical Trial, Phase II OR Clinical Trial, Phase III OR Clinical Trial, Phase IV OR Controlled Clinical Trial OR Pragmatic Clinical Trial	Exact keywords are limited to "Major Clinical Study" OR "Clinical Article" OR "Clinical Trial" OR "Controlled Clinical Trial"
Year	1970–2020	1970–2020
Language	English	English

journals and conference proceedings), document type, keywords, abstract, and number of times cited. The performance mapping and science mapping of the bibliometric data were also performed. Performance mapping helps in evaluating the impact of authors, journals, and documents, among others, on a given scientific field based on measures such as the h-index and number of documents published [16,17]. Science mapping helps to understand the dynamic and structural aspects of a scientific field [18]. We visualized the emerging trends, the conceptual structure of the field, and the social structure defining the collaborative relationships between authors and countries. The metrics and methods for performing the performance mapping and science mapping are presented below.

3. Performance mapping

1) Generic attributes of the dataset

It provides an overview of the information present in the bibliographic data, such as total number of articles, sources, keywords, authors, and a few related collaborative measures as follows: (1) documents per author=documents/authors; (2) authors per document=authors/documents; (3) co-authors per document=authors' appearances/documents; and (4) collaborative index=total authors of multi-authored articles/total multi-authored articles [19].

2) Author-level metrics

The metrics employed to identify the most influential/impactful authors include the total number of documents published, Hirsch index (h-index), g-index, and m-index. An author with an index of "h" has published "h" papers, each of which has been cited at least h times in other papers [20]. It is a hybrid metric that measures both the productivity and the citation impact of an author. The h-index does not take into account highly cited papers and it also tends to increase with time, favoring authors with longer careers. Variants of the h-index, namely, g-index and m-index, have been proposed to overcome these limitations [21]. The g-index is where the top "g" articles have together received "g" citations [22]. It gives weight to highly cited papers and is higher or the same as the h-index. The m-index is the h-index divided by the number of years that an author has been active [22]. It is thus not time-dependent and adjusts for the career length of an author. Since citation information is not available in PubMed, only authors who are influential based on the number of publications have been provided for it. In addition, the top 10 authors' scientific production was analyzed over time.

3) Source-level metrics

The total number of articles published in a source along with h-index, g-index, and m-index were used as source-level performance metrics. The h-index, although initially proposed for authors, is also being used successfully for measuring the impact of sources [23]. Bradford's law of scattering was also employed to identify the core journals [24,25]. According to Bradford's law, if journals are sorted in descending order of the number of documents they published and grouped into tertiles (each with one-third of all articles), then the number of journals in each tertile will follow a geometric progression (i.e., $1:n:n^2$).

4) Country-level metrics

The authors' affiliations were identified and analyzed to calculate the numbers of single-country publications (SCP) and multi-country publications (MCP). This helps to understand the intensity of inter-country collaboration. MCP indicates the number of documents where at least two of the co-authors are from different countries. The MCP ratio was calculated as the ratio of MCP to the total number of articles published. PubMed only provides the first author's affiliation for papers published in 2014 and earlier [26]. Hence, the country-level metrics were only calculated for Scopus data.

5) Document-level metric
The number of global citations (GC) received per year was employed as a metric to evaluate the impact of an article.

4. Science mapping

1) Conceptual structure
Conceptual structure helps in exploring the relationships between words or identifying the subfields [27,28]. The conceptual structure is generated by performing factorial analysis, in this case multiple correspondence analysis of the keyword/document matrix [29]. Factorial analysis helps in visualization by mapping high-dimensional data to low-dimensional space. Further, the clusters are identified by hierarchical clustering [30].

2) Social structure
We studied the collaborative pattern at two different levels: authors and countries. This was studied by visualizing the co-authorship network, where nodes represent entities such as authors or countries and edges between them represent collaboration between them [31,32]. The size of a node depends on the total frequency of occurrence of the entity and the thickness of edges represents the co-occurrence frequency of the entities. The thicker the edge, the stronger the connection between two nodes. The nodes are also further clustered using the Louvian method [33] and the minimum number of edges was set to 2 to avoid one-time collaborations. Isolated nodes were removed from the visualization. The nodes present in the same cluster are more similar to each other than the nodes in other clusters.

Results

The results of the performance mapping and science mapping are presented below.

1. Generic attributes of the dataset

The total numbers of clinical studies available in PubMed and Scopus were 1,302 and 3,470, respectively, from 1970 to 2020. These studies were published in 309 different sources in PubMed, and 623 different sources in Scopus. Among all of the documents, almost 4%–5% of them were authored by a single individual, while the rest involved collaborations between two or more authors. For more details, see Supplement 2.

Fig. 1 shows the annual scientific production extracted from PubMed and Scopus. Scopus showed a high jump in the number of articles in the years 2016–2019. The highest numbers of papers were published in 2019 and 2018 for Scopus and PubMed, respectively. Fig. 1 also shows the average citations per year. This is only available for Scopus, since citation information is not provided by PubMed. The peaks denote the average of the highest number of citations achieved by the articles in a particular year; for example, one or more articles published in 1999 achieved the highest citations. One of the articles by Hilibrand et al. [34] in the *Journal of Bone & Joint Surgery*

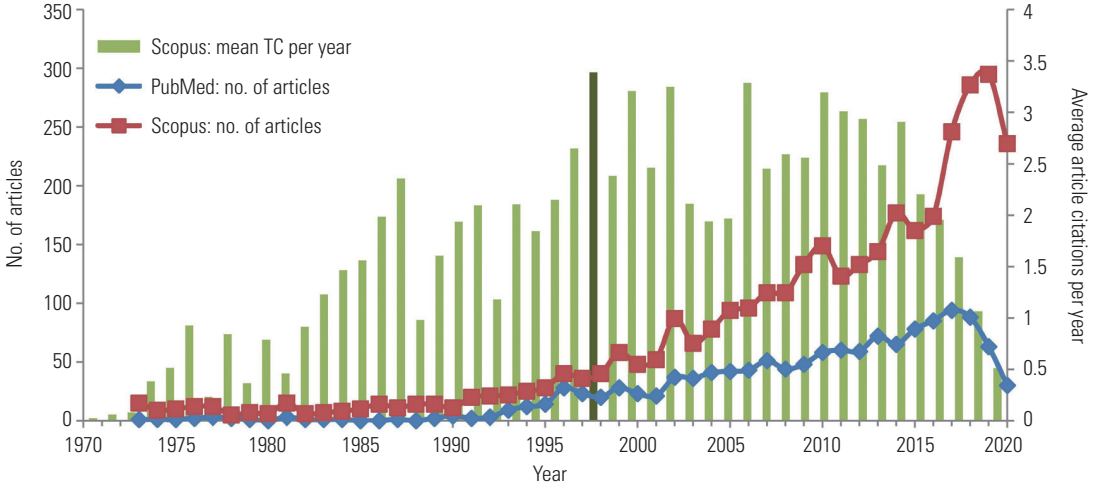

Fig. 1. Line plots show the annual scientific production from 1970 to 2020 for PubMed and Scopus bibliometric data. Bar plot shows the average article citations per year for Scopus data. TC, total citations.

Table 2. Top 10 authors in terms of number of articles published

Scopus						PubMed	
Authors	No. of articles	h-index	g-index	m-index	Total citations	Authors	No. of articles
Fehlings MG	68	23	41	1.211	1,885	Fehlings MG	30
Yuan W	45	20	32	0.909	1,061	Vaccaro AR	16
Liu H	40	10	15	0.625	318	Lurie JD	14
Ito K	36	13	25	0.867	634	Riew KD	14
Riew KD	32	17	32	0.68	1,289	Albert TJ	13
Wang Y	32	9	16	0.529	295	Sasso RC	13
Chen Y	31	15	23	1.154	544	Weinstein JN	13
Zhang Y	31	11	21	0.688	445	Zhao W	13
Benzel EC	30	16	30	0.516	1,194	Anderson PA	12
Shen Y	30	10	15	0.667	273	Christensen FB	12

h-index: an author has a h-index of 'h' when they have h papers that have been cited h times at least. g-index: where the top 'g' articles have together received 'g' citations. m-index: the H-index divided by the number of years that an author has been active.

in 1999 has been cited 1,148 times. This article focuses on the need to address adjacent segment degeneration in cases of anterior cervical arthrodesis.

2. Analysis of authors

The total numbers of authors were 5,864 and 10,568 in PubMed and Scopus data, respectively. The numbers of documents per author were 0.22 and 0.328 from PubMed and Scopus data, respectively, while the numbers of authors per document were 4.5 and 3.05.

The most influential authors in terms of the number of articles published were Fehlings MG (n=68), Yuan W (n=45), Liu H (n=40), Ito K (n=36), and Riew KD (n=32) from Scopus data (Table 2). From PubMed, the most influential authors were Fehlings MG (n=30), Vaccaro AR (n=16), Lurie JD (n=14), Riew KD (n=14), and Albert TJ (n=13).

In terms of impact, the most important authors were Fehlings MG (h-index=23, g-index=41, m-index=1.211), Yuan W (h-index=20, g-index=32, m-index=0.909), Riew KD (h-index=17, g-index=32, m-index=0.680), Benzel EC (h-index=16, g-index=30, m-index=0.516), and Kopjar B (h-index=16, g-index=25, m-index=1.60). The top author production over time is shown in Supplement 3. For example, in 2017, Fehlings MG published 14 articles and was cited approximately 48 times, while Yuan W published nine articles in 2012 and was cited 44.3 times.

The authors' collaborative network in Fig. 2 shows three major groups, with Fehlings MG (cluster 3), Yuan W (cluster 2), and Ito K (cluster 1) emerging as dominant authors. The clusters appear to be associated with the geographical locations/affiliation countries of the authors. There is also a fourth cluster (cluster 4) with only three authors in it (Wu JC, Cheng H, Huang WC).

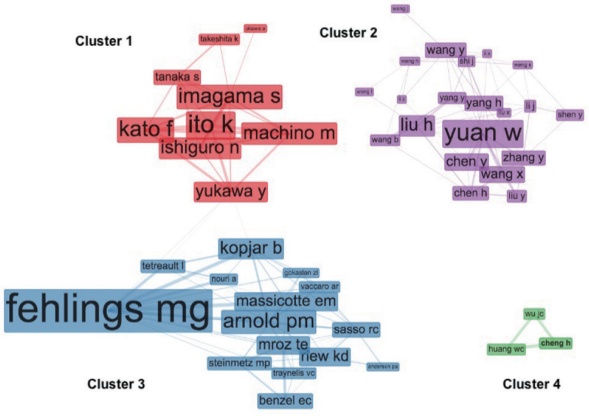

Fig. 2. Authors' collaboration network.

3. Analysis of sources

The most relevant sources in terms of the number of articles published are presented in Fig. 3A and B for Scopus and PubMed, respectively. In the Scopus data, *Spine* (n=439), *Journal of Neurosurgery: Spine* (n=190), *World Neurosurgery* (n=179), *European Spine Journal* (n=175), and *Spine Journal* (n=110) were the most relevant. From PubMed, *Spine* (n=164), *European Spine Journal* (n=71),

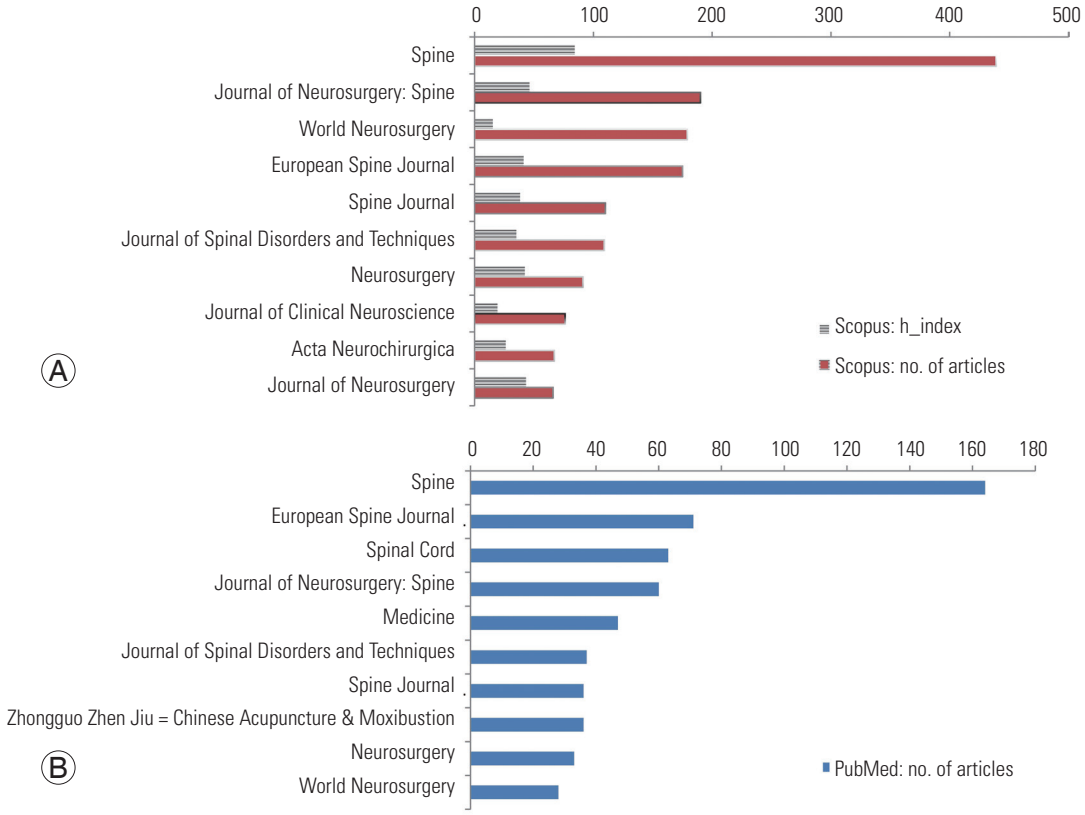

Fig. 3. Top 10 journals based on number of articles and h-index extracted from Scopus **(A)** and PubMed **(B)**.

Spinal Cord (n=63), *Journal of Neurosurgery: Spine* (n=60), and *Medicine* (n=47) were the prominent journals.

In terms of source impact, *Spine* (h-index=84, g-index=126, m-index=1.86), *Journal of Neurosurgery: Spine* (h-index=46, g-index=74, m-index=2.8), *Journal of Neurosurgery* (h-index=43, g-index=66, m-index=0.93), *Neurosurgery* (h-index=42, g-index=68, m-index=1.05), and *European Spine Journal* (h-index=41, g-index=62, m-index=1.41) were the most important ones.

The core journals identified by Bradford's law of scattering were *Spine*, *Journal of Neurosurgery: Spine*, *World Neurosurgery*, *European Spine Journal*, *Spine Journal*, and *Journal of Spinal Disorders and Techniques* from Scopus data. Similarly for PubMed, the journals *Spinal Cord* and *Medicine*, among others, were also identified as core journals (Supplement 4).

4. Analysis of relevant countries

Collaborative indexes of 4.66 and 3.16 were obtained from PubMed and Scopus data, respectively. The performance of the countries in terms of numbers of SCP and MCP is shown in Fig. 4.

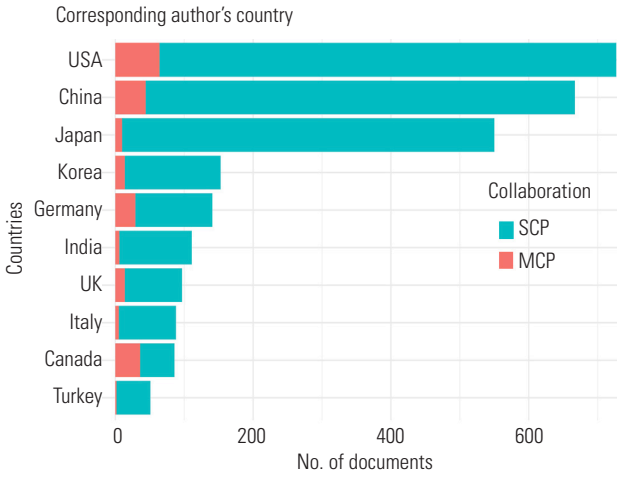

Fig. 4. Top 10 countries based on number of multi-country publications (MCP) and single-country publications (SCP).

The most relevant countries by the number of publications produced were United States (n=727, frequency rate [freq]=0.231), China (n=667, freq=0.212), Japan (n=550, freq=0.175), South Korea (n=153, freq=0.048), Germany (n=141, freq=0.044), and India (n=111, freq=0.035).

Among the top 10 countries, Canada (MCP ratio=0.418), Germany (MCP ratio=0.205), United Kingdom (MCP ratio=0.144), South Korea (MCP ratio=0.915), and United States (MCP ratio=0.088) were the countries with the highest MCP ratio (Supplement 5).

In terms of total citations (TC), the most relevant countries were United States (TC=31,427), Japan (TC=16,338), China (TC=6,534), Germany (TC=3,676), and United Kingdom (TC=2,864) (Supplement 5). However, in terms of average article citations (AAC), Belgium (AAC=92.61), Lebanon (AAC=46.33), United States (AAC=43.22), Czech Republic (AAC=10.65), and Israel (AAC=39.53) were the top five countries.

Supplement 6 shows the countries' collaborative network**.** Cluster 1 shows strong collaboration among China, United States, Japan, Canada, and South Korea. Cluster 2 consists of countries such as India, Netherlands, Brazil, Singapore, Ireland, and Turkey. Cluster 3 mostly represents the connections among European countries (Germany, United Kingdom, Italy, France, Italy, Sweden, Greece, and Spain).

5. Analysis of documents

Table 3 lists the top 10 cited documents globally [34-43]. The top article was published in 1999 by Hilibrand et al. [34], entitled "Radiculopathy and myelopathy at segments adjacent to the site of a previous anterior cervical arthrodesis." It has the highest number of GC (1,148), as well as the highest number of TC per year of 49.91. This article is significant with respect to this topic as it describes a landmark study involving significant analysis of cervical arthrodesis and its causal relationship to myelopathy and radiculopathy. Over the years, this point has been well established by subsequent studies. The second most cited article (GC=549, GC per year=36.60) was written by Fountas et al. [35], focusing on anterior cervical discectomy and fusion-associated complications.

6. Analysis of emerging trends

Fig. 5A and B shows the different trends emerging over time in the PubMed and Scopus datasets. The y-axis represents the logarithmic frequency of the occurrence of words. From PubMed, it can be observed that the term "laminoplasty" had the highest occurrence in year 2016, while "total disk replacement" did in 2015. From Scopus data, "anterior cervical discectomy," "fusion," and "anterior cervical decompression and fusion" were the most commonly occurring words around 2016–2017.

7. Conceptual structure

Fig. 6A and B shows the conceptual structure covered by

Table 3. Top 10 globally cited documents

Author (year)	Journal name	Article name	LC	GC	GC per year
Hilibrand et al. [34] (1999)	J Bone Joint Surg Am	Radiculopathy and myelopathy at segments adjacent to the site of a previous anterior cervical arthrodesis	283	1,148	49.91
Fountas et al. [35] (2007)	Spine (Phila Pa 1976)	Anterior cervical discectomy and fusion associated complications	96	549	36.60
Mummaneni et al. [36] (2007)	J Neurosurg Spine	Clinical and radiographic analysis of cervical disc arthroplasty compared with allograft fusion: a randomized controlled clinical trial	102	432	28.80
Heller et al. [37] (2009)	Spine (Phila Pa 1976)	Comparison of BRYAN cervical disc arthroplasty with anterior cervical decompression and fusion: clinical and radiographic results of a randomized, controlled, clinical trial	83	364	28.00
Emery et al. [38] (1998)	J Bone Joint Surg Am	Anterior cervical decompression and arthrodesis for the treatment of cervical spondylotic myelopathy: two to seventeen-year follow-up	61	335	13.96
Goffin et al. [39] (2004)	J Spinal Disord Tech	Long-term follow-up after interbody fusion of the cervical spine	83	331	18.39
Hurwitz et al. [40] (2008)	Spine (Phila Pa 1976)	Treatment of neck pain: noninvasive interventions: results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders	2	312	22.29
Benzel et al. [41] (1991)	J Spinal Disord	Cervical laminectomy and dentate ligament section for cervical spondylotic myelopathy	118	306	9.87
Katsuura et al. [42] (2001)	Eur Spine J	Kyphotic malalignment after anterior cervical fusion is one of the factors promoting the degenerative process in adjacent intervertebral levels	82	289	13.76
Fraser et al. [43] (2007)	J Neurosurg Spine	Anterior approaches to fusion of the cervical spine: a metaanalysis of fusion rates	87	279	18.60

LC, local citations; GC, global citations; TGC, total global citations per year.

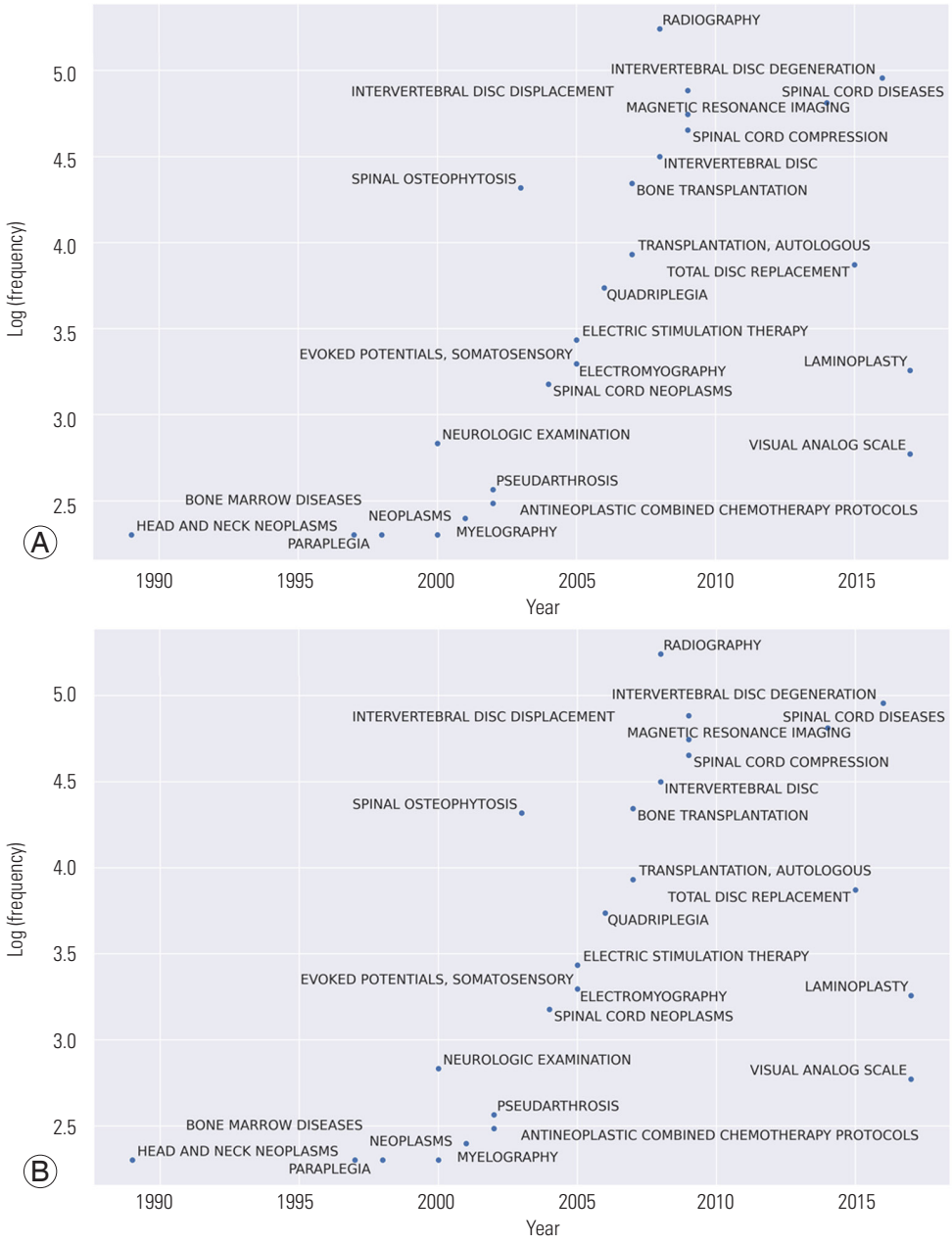

Fig. 5. Trend topics: x-axis represents the year, y-axis represents the corresponding log (frequency) of occurrence of a word: **(A)** PubMed and **(B)** Scopus.

a field. Words placed close to each other in the space have come together in a large portion of documents, whereas words placed away from each other might have come together in only a small number of articles. Words present in the same clusters might represent the same concept/topic. Three main clusters were found using PubMed data and two using Scopus data.

Discussion

CSM is one of the most important degenerative diseases related to the spine. While its importance clinically cannot be disputed, a comprehensive scientometric analysis of the research provides interesting insights, such as on the most influential authors, documents, countries, shifting trends, author collaborative networks, and co-occurrence of conceptual terms. First, we observed that there were more ar-

ticles in Scopus than in PubMed. This could be attributed to the fact that Scopus also includes records from Medline and EMBASE databases, among other sources, and has more than double the number of records of PubMed [44].

The increasing number of publications each year shows increasing interest in this field of study among researchers. The steep decline in 2020 could have been due to coronavirus disease 2019 and subsequent lockdowns, which may have restricted the access to infrastructure and resources required to conduct research. This may be in part attributable to problems with scheduled follow-ups. The analysis of the importance of journals in terms of citations and h-index reveals that *Spine* is a leading journal among the research community, along with *European Spine Journal*, *Journal of Neurosurgery*, and *Spine*, as observed in both databases.

From the h-index and number of publications produced, Fehlings MG emerges as the top author as per both PubMed and Scopus data, although the absolute number of publications differs between the two databases. The country-wise data reveal that the majority of the published and highly cited works are from the United States, but Canada tops the list in terms of collaboration. Developing countries contributed less among the published results as well the collaborative networks, which may have been because of the need to deal with different research limitations, restricted resources, and lack of opportunities. This is despite the presence of a larger proportion of patients in these countries, so more results, research, and collaborations from these countries are awaited.

The trend analysis according to the frequency of words in publications showed some interesting findings. For example, less invasive and motion-preserving procedures are a new focus of interest, as is the management of CSM. Surgence of objective evaluation through scales, advanced radiological investigations including MRI, advanced nonoperative management including electric stimulation therapy are showcasing the relevant time trends. Fig. 5B reveals the gradual evolution of complex, more physiological motion-preserving, less invasive surgical procedures, and the refinement and advancement of diagnostic modalities.

The conceptual structure of the publications shows that the words present in cluster 2 represent the demographics, etiopathogenesis, symptomatology, and management options, focusing predominantly on the nonoperative options (Fig. 6A). Cluster 1 with the terms "arthroplasty," "neck pain," "intervertebral disc displacement," and "discectomy" represents the pathology, symptoms, and newer treatment options of CSM. Cluster 3 represents a spectrum of analogous clinical conditions lower down the vertebral column. Similarly, in Scopus data, two important clusters can be observed (Fig. 6B). Cluster 1 includes terms such as "intervertebral discectomy," "neck disability index," "cervicobrachial neuralgia," and "visual analog scale," which encompass the symptomatology, scientific-scale-based objective evaluation of symptoms, and surgical removal of the offending culprit (i.e., disc). Cluster 2 includes the terms "computer-assisted tomography," "decompression," "laminoplasty," "NMR," and "stenosis," broadly covering the patho-etiology, diagnostic modalities of relevance, and the surgery commonly performed for CSM.

Changing patterns in key areas of research (internal fixation to cervical disc replacement) indicate a gradual shift from fusion to segment and motion-sparing procedures.

1. Strengths and limitations

We have performed a comprehensive bibliometric analysis of 50 years of research on CSM, identifying important authors, countries, research papers, groups, and trending topics. The main strengths of this work lie in the data used and the statistical analysis providing actionable insights, such as the emergence of newer noninvasive methods and two main concepts or topics being targeted in this field. Our work also draws strength from the comprehensiveness of the Scopus and PubMed databases. While being useful troves of information, they present different sets of opportunities and limitations to analyze the bibliometric data. For example, Scopus provides more detailed information related to citations and affiliations of all authors of the publications, which is not provided by PubMed. However, PubMed is freely available to the research community [45]. Although there are some differences in the results obtained from the two databases due to the differences in data collection strategies, overall there are significant overlaps in the top authors, journals, and structure, which help us to analyze the overall trends. Since bibliometrics is a time-dependent analysis, our work may have missed newer articles and authors who are particularly important but have lost out due to a smaller number of citations or perhaps indexing. Our work also does not consider the open-access but relatively inaccessible Google Scholar database due to the presence of noisy data [44].

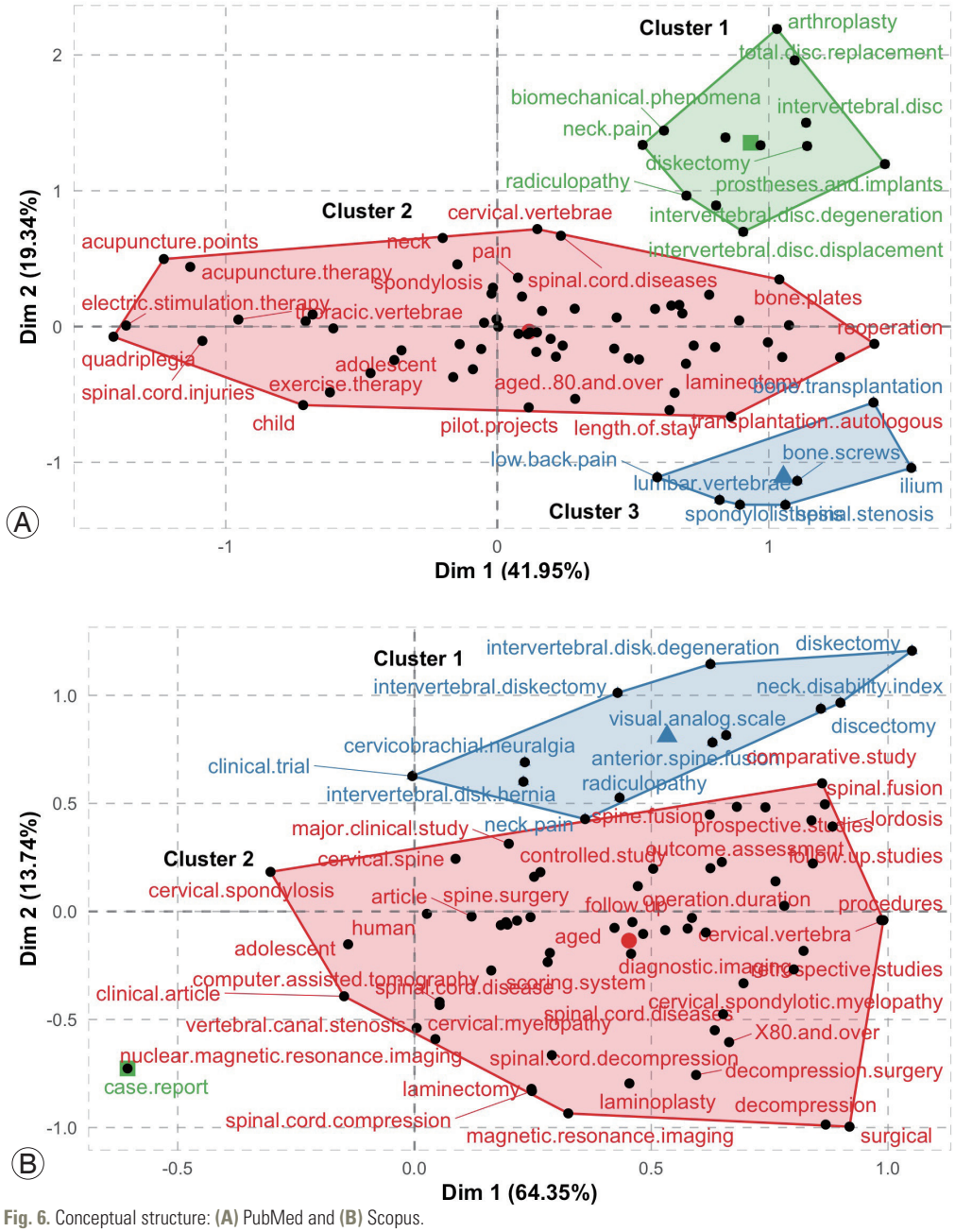

Fig. 6. Conceptual structure: **(A)** PubMed and **(B)** Scopus.

Conclusions

This work constitutes a vivid presentation of the trends and evolution of CSM over the last 5 decades, which is expected to be useful for researchers and clinicians alike who want to promote research in this field.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Supplementary Materials

Supplementary materials can be available from https://doi.org/10.31616/asj.2021.0239. Supplement 1. Search queries. Supplement 2. Table listing the generic attributes of bibliometric data extracted from PubMed and Scopus. Supplement 3. Top-authors' production over time: (A) PubMed and (B) Scopus. Supplement 4. Bradford's law: (A)

PubMed and (B) Scopus. Supplement 5. Table listing the top 10 most-cited countries. Supplement 6. Countries of research output and their collaboration network.

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