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Comprehensive Analysis of Scientific Output in Hip and Knee Arthroscopy

Komplexní analýza vědeckých výstupů artroskopie kyčle a kolena

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ABSTRACT

PURPOSE OF THE STUDY

A global bibliometric comparison of the level of scientific interest and output in the two research areas hip and knee arthroscopy (H-ASC and K-ASC) was carried out. In addition, the different degrees of publication activity in the countries and institutes performing this research were investigated.

MATERIAL AND METHODS

Publications from 1945–2020 listed in the Web of Science Core Collection were included in the study. Using the web application Science Performance Evaluation (SciPE), quantitative and qualitative aspects were evaluated. Subsequently, the date of publication, author information, and other metadata were analysed.

RESULTS

Since 1945, 3,924 studies have been published on K-ASC and 2,163 on H-ASC. The majority of the publications which have appeared since 2016 dealt with the topic of H-ASC (H-ASC: 241.2 publications/year; K-ASC: 217.4 publications/year). The USA published the most on both topics (H-ASC: 1,123 publications; K-ASC: 1,078 publications). More countries and institutes participated in K-ASC (3,008 institutes, 82 countries) than in H-ASC (103 institutes, 57 countries). The ten institutes with the most publications accounted for 36.71% and 12.34% of all publications on H-ASC and K-ASC, respectively. H-ASC received 78.12% of its funding from private sponsors while K-ASC was supported mainly by governmental/non-profit sponsors (70.92%).

CONCLUSIONS

This study provides the first scientific comparison between H-ASC and K-ASC. Measured by qualitative and quantitative aspects, K-ASC was the most flourishing research area overall. In the last ten to five years, interest has shifted towards H-ASC with an increasing number of publications and a higher rate of citations.

Key words: knee arthroscopy, hip arthroscopy, bibliometric comparison.

INTRODUCTION

The number of minimally invasive surgical procedures is increasing in all medical disciplines and for all organs (7). In orthopaedics, hip arthroscopy (H-ASC) and knee arthroscopy (K-ASC) have become common surgical options for treatment of a variety of pathologies (1, 13, 36). This soft-tissue-friendly approach enables faster wound healing and rehabilitation and has made arthroscopy one of the most frequently performed outpatient surgical interventions. Critical consideration should be given to whether the fairly minor surgical procedure is not performed beyond guideline-recommended indications and is supported by current evidence (28, 21). In addition to a general increase in the number of arthroscopies performed, there has also been a widespread increase in scientific publications (seen as the vehicle through which new discoveries in this field of orthopaedics are conveyed to the rest of the world (29, 39).

Thematically subordinated to infometry, bibliometric analyses evaluate the scientific development in certain fields of research in accordance with scientific standards. By analysing the data, conclusions can be drawn about quantitative aspects (number of publications and citations), semi-qualitative aspects (research performance and Hirsch (H-index) and the cooperation behavior of countries and leading institutes (12, 38). A comprehensible visualisation of the data (heat maps and diagrams) facilitates comparable and transparent analyses of different topics, countries, and institutions.

With the increasing number of studies from various countries and the opportunity to publish them in as many as 82 different orthopaedic journals (6) alone, manual analysis of publications is becoming increasingly cumbersome and requires digital support. Besides

the evaluation by the analysis function of the Web of Science database (24, 43), the Science Performance Evaluation (SciPE) software is a modern web application for publication analysis (34). Within the scope of the present study, a global bibliometric comparison between H-ASC and K-ASC was carried out.

It remains unclear whether the increasing number of knee and hip arthroscopies is based on an equally growing scientific basis. The present study is designed to clarify not only the scientific progress over time but also whether there are regional and qualitative differences in the two surgical disciplines.

MATERIAL AND METHODS

Study design

This study used a bibliometric method to analyse articles on H-ASC and K-ASC. All publications between 1945 and 2020 were enrolled, analysed, and compared in accordance with the method for bibliometrics (10, 17, 18, 20, 25, 41).

Database and search strategy

The data collection was carried out using the worldwide established multi-disciplinary search platform for bibliographic databases Web of Science Core Collection (WoS) (24, 40, 43). Cross-checks were performed with other databases such as PubMed to minimise the risk of missing articles. To ensure high quality and comparability of the results, the search only covered the topic of articles. In order to include as many articles as possible on the topics H-ASC and K-ASC and at the same time prevent the inclusion of non-topic-related articles, broad but specific search terms were used in accordance with the WoS guidelines (H-ASC: TS=((arthroscop* and hip) or (arthroscop* and cam) or (arthroscop* and FAI) or (arthroscop* and impingement) or (arthroscop* and femoral) or (arthroscop* and pincer) not (TS=shoulder)); K-ASC: TS=((arthroscop* and knee) or (arthroscop* and menisc*) or (arthroscop* and cruciate)). Hence, the search discovered 6,087 papers (H-ASC: 2,163; K-ASC: 3,924) published in the pre-defined period from 1945 to 2020.

Analysis by the Science Performance Evaluation (SciPE)

All papers matching the search terms were extracted in a plain text form from the WoS database, providing all relevant information on the publications (e.g., participating countries, institutes, authors, publication data). After importing the plain text into the web-based application SciPE, various specific data tables were generated for H-ASC. The same process was carried out with the plain-text publications for K-ASC. SciPE performed a comparison of all identified institutes using a freely available ranking list for universities (37), as described elsewhere (34). All analyses were performed using the affiliations of the articles' first author. All publications were allocated to the respective publication date. From this, the chronological course in H-ASC and K-ASC was compared. The analysis also allowed a chronological correlation to individual countries, institutions and authors. To evaluate the scientific performance of the topic under investigation (country, institute or author), the H-Index (14), the number of citations, epidemiological and demographic aspects were included.

Analysis by the Web of Science

The analysis feature of the Web of Science website allows a more in-depth analysis of the funding of the publishing authors provided the data was given in the publications. Here, a manual differentiation based on online research was made between private and public/non-profit institutions.

RESULTS

Publication record

The total number of publications (H-ASC and K-ASC) has increased almost exponentially since records were first compiled. The first publications on K-ASC were published in 1968 and the total number reached 3,924 by the end of 2020. The first publications on H-ASC were published 12 years later than those on K-ASC (1980) and by the end of 2020 the total number had reached 2,163. Compared with K-ASC, the publication rate in the H-ASC subject area has increased significantly in recent years.

In the period between 2005 and 2009, an average of 92 publications per year were published for K-ASC and 45.2 for H-ASC. In 2016, there were more publications on H-ASC for the first time (H-ASC: 212 publications vs. K-ASC: 198 publications). In the last five years, the publication rate for H-ASC exceeded the rate for K-ASC (H-ASC: 241.2 publications/year vs. K-ASC: 217.4 publications/year) (Fig. 1).

Countries

Between 1945 and 2020, 57 countries participated in research on H-ASC and 82 in research on K-ASC. The research on H-ASC is particularly influenced by a few countries. The five most active countries are responsible for 72.59% of all publications on H-ASC and merely 49.87% on K-ASC. Except for the United States of America (USA) (H-ASC: 1,123 publications vs. K-ASC: 1,078 publications), all leading countries have published more on K-ASC than on H-ASC. Individual countries excelled in the analysis, notably in individual research areas.

Even though the USA play a leading role in both research areas, this dominance is particularly noticeable in H-ASC. The most productive countries in K-ASC research (USA (1,078 publications), Germany (257), England (233), Peoples' Republic of China (206) and South Korea (183)) differ slightly from those in H-ASC (USA (1,123 publications), England (134), Canada (120), Germany (104) and Australia (89)) (Fig. 2).

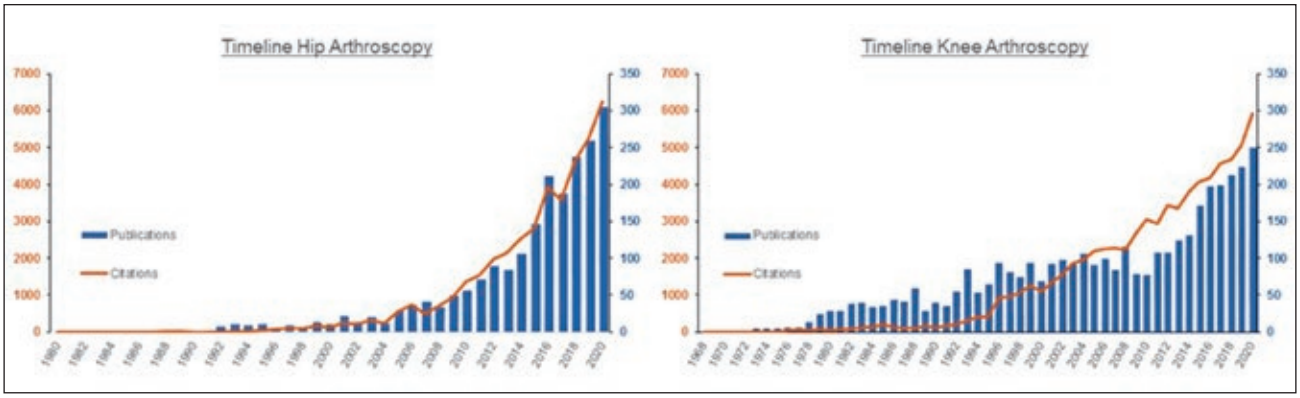

Fig. 1 Visualised representation of the publication (y-axis) and citation rate over time (x-axis). The blue column represents the publications. The orange line represents the citations. The left graph depicts the course of hip arthroscopy, the right graph that of knee arthroscopy.

Institutes

In the investigated K-ASC sample, 211 publications (5.38%) did not name any of the institutes involved. In H-ASC, the authors did not provide the names of institutes in 144 publications (6.57%).

In contrast to the total number of publishing institutes (H-ASC: 103 institutes; K-ASC: 3,008 institutes), the relative publication rate (publications/institutes) was higher for H-ASC than for K-ASC (publication rate: H-ASC: 9.57 vs. K-ASC: 1.23).

As with the publishing countries, the H-ASC research landscape was characterised by a small number of institutes. For H-ASC, 36.71% of all publications were accounted for by the ten institutes with the highest publication activity. The publication ratio of 12.34% for the leading institutions on K-ASC was much more heterogeneous.

The scientific background of the publishing institutes was much more diversified for H-ASC than for K-ASC. Five non-university institutes were among the top ten most active publishers, which accounted for 21.18% of all publications on H-ASC.

Citation analysis

Papers on H-ASC were cited in 10,772 articles which resulted in a total of 45,463 citations in this field of research (21.02 citations/publication). Of the total number of publications, 18,793 (41.34%) citations were self-citations. The results of K-ASC research were of interest to 31,907 other publications (19.17 citations/publication). In addition, only 18.36% of 75,233 citations were self-citations (13,814 publications).

During the entire period from 1945 to 2020, K-ASC had a higher H-index than H-ASC (K-ASC: 106 vs. K-ASC: 96). In the last ten years (2011-2020), there was an almost equal number of publications (K-ASC: 1,737 publications; H-ASC: 1,711 publications), but a higher number of citations on the subject of H-ASC, resulting in a significantly higher H-index for H-ASC publica-

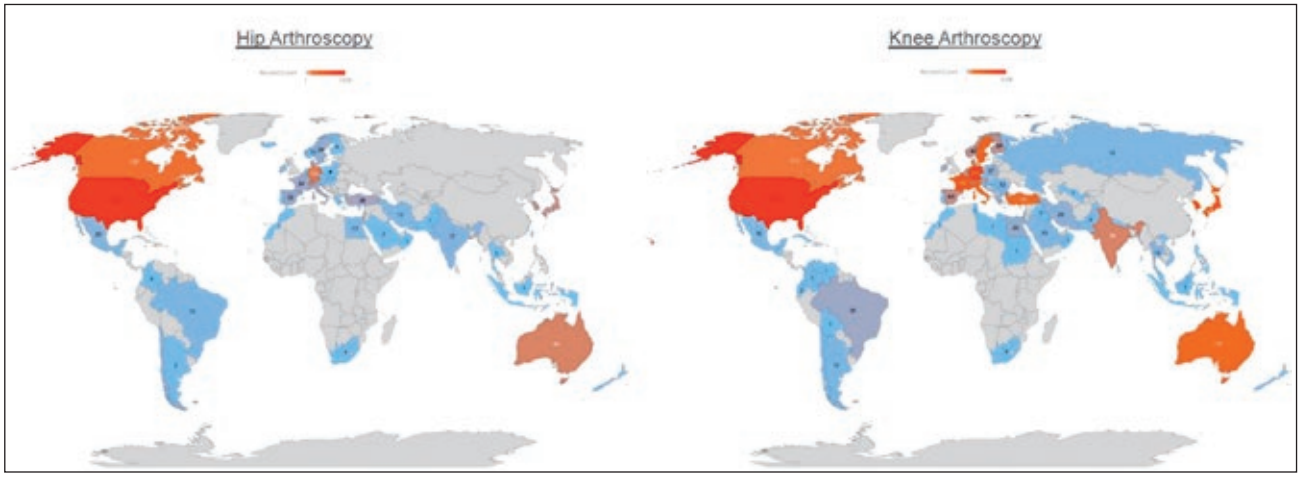

Fig. 2. Heatmap of the publication performance for the individual countries. Ascending colour graduation from blue (few publications) to red (many publications). On the left side are the publications on hip arthroscopy and on the right on knee arthroscopy.

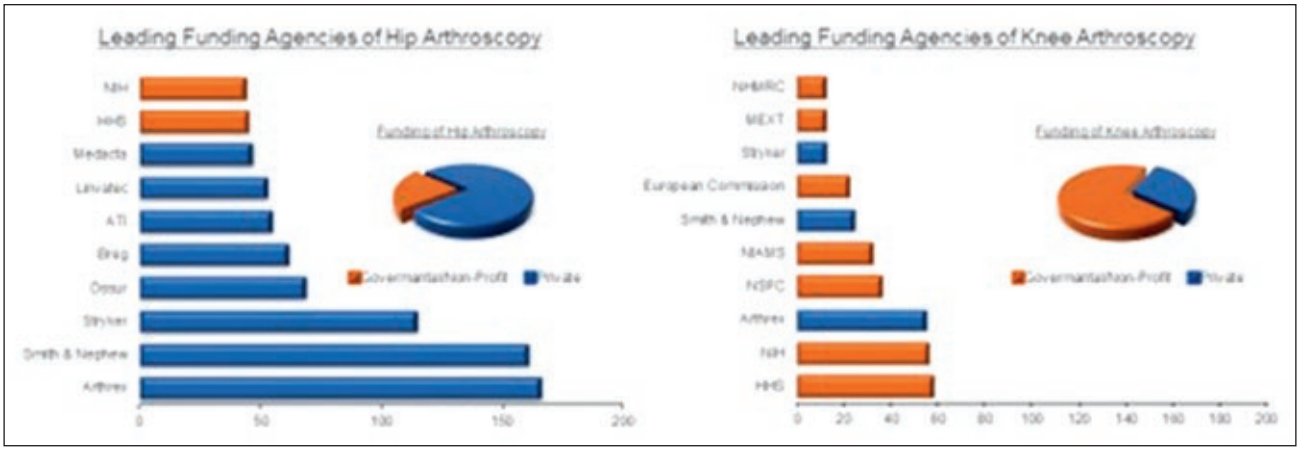

Fig. 3. Visualised representation of the leading funding agencies and the ratio of governmental and private funding. The graph on the left depicts the ten leading funding agencies. Listed from top (least) to bottom (most). The pie chart represents the ratio of all agencies involved. The blue bars and the blue part of the pie chart represent private agencies. The orange bars and the orange part of the pie chart represent governmental/non-profit agencies. The two figures on the left illustrate the ratio in hip arthroscopy. The two figures on the right show the ratio in knee arthroscopies. Abbreviations: NIH: National Institute of Health (USA), HHS: United States Department of Health Human Services, NHMRC: National Health and Medical Research Council of Australia, MEXT: Ministry of Education Culture Sports Science and Technology Japan, NIAMS: National Institute of Arthritis Musculoskeletal Skin Diseases, NSFC: National Natural Science Foundation of China.

tions than for K-ASC during this period (H-Index: K-ASC: 50; H-ASC: 71) (Fig. 1).

Funding

The authors of 1,666 publications (75.97%) on H-ASC and of 3,473 publications (88.51%) on K-ASC did not list any financial support.

In total, researchers in the field of K-ASC received funding from 624 organisations, whereas 271 organisations supported researchers in H-ASC. The three leading organisations who funded H-ASC research were Arthrex (166 publications), Smith & Nephew (161 publications) and Stryker (115 publications). The K-ASC researchers' leading funders were the United States Department of Health Human Services (58 publications), National Institutes of Health USA (56 publications) and Arthrex (55 publications). Thus, H-ASC researchers were primarily supported by private companies (78.12%) and K-ASC researchers by government/non-profit institutions (70.92%) (Fig. 3).

Authors

During the period 1945 to 2020, 4,948 authors were involved in research on H-ASC. More than twice as many contributed to K-ASC research (11,089 researchers). There was an average of 2.29 authors for every publication on H-ASC and 2.83 on K-ASC. The ten leading authors (0.2% of all authors) in the H-ASC subfield participated in 7.31% of all publications. The ten authors with the most publications on K-ASC (0.09% of all authors), on the other hand, participated in 1.5% of all publications.

The three most eminent authors in H-ASC published markedly more than those in K-ASC (H-ASC: 1. 155 publications, 2. 114 publications, 3. 95 publications; K-ASC: 1. 34 publications, 2. 33 publications, 3. 29 publications).

DISCUSSION

To the best of our knowledge, this is the first bibliometric study to examine scientific publishing performance in the fields of research on H-ASC and K-ASC.

Since 1945, 6,087 papers on H-ASC and K-ASC have been published. In the last ten years there has been a sharp increase in publications worldwide. This shows a significant growth in scientific interest in these minimally invasive techniques. Arthroscopic procedures enable a faster healing process after surgery, which enables patients to resume sporting and professional activities sooner than after conventional surgery. Recently, there has been an especially high number of publications on the topic of H-ASC, which is nowadays mainly performed to treat femoroacetabular impingement (FAI) (26), a condition which was previously difficult to treat by other methods. Even though the total number of publications on K-ASC is still higher, the ratio of publications is likely to balance out in a few years if the current trend continues. Publication behavior regarding K-ASC resembles that for arthrosis research[31], with H-ASC showing almost exponential growth, especially in recent years. In addition to a general increase in the number of publications in medicine (8, 23), the rising publication rate can be explained by, among other things, increasing technical and technological progress, resulting in increased procedural options and novel indications. In addition, the research areas of H-ASC and K-ASC are also subject to a constantly increasing pressure to publish („publish or perish“) (2). The fact that publications on H-ASC began

nearly 15 years after K-ASC is probably less due to the scientific interest at the time than to the circumstance that H-ASC only later became a component in the treatment of hip pathologies.

In the national comparison, there is a slight divergence between K-ASC and H-ASC regarding publication behavior. As in other scientific disciplines (15, 16, 17, 22), the USA is the leading nation for research on both H-ASC and K-ASC. The gap between the USA and the respective countries with the second highest number of publications is greater for H-ASC. The United Kingdom, Germany, Japan, Republic of Korea, and Australia have made significant contributions to scientific performance in both research areas, albeit with a different weighting. This observation is largely consistent with other bibliometric studies (4, 33) and the worldwide research index (35). Only China was underrepresented in comparison with the renowned Nature Index (35). It is likely to be only a matter of time until China also plays a greater role in H-ASC and K-ASC research.

A noticeable aspect in the distribution of the institutes involved and the financial support is the participation of private, non-governmental, or non-profit organisations. For example, research in the field of arthroscopic knee surgery rests on university shoulders and non-profit fundings. H-ASC research, on the other hand, is influenced primarily by private companies such as Arthrex, Smith & Nephew and Stryker and not entirely by university institutes.

A reason for this trend could be related to procedural complexity (19). K-ASC is a surgical procedure with a variety of indications and is part of clinical routine in orthopaedic practice. H-ASC, on the contrary, is mainly performed by a few surgeons in specialised centers (9, 11, 27).

Limitations

A bibliometric analysis can only be as good as the corresponding search term. Hence, a search term which is too specific would exclude a large number of relevant articles whose titles do not fit into the search pattern. A lack of restriction, on the other hand, would lead to the inclusion of articles unrelated to the topic. The WoS was used as the source for data collection. Furthermore, there are, for example, meniscus and ACL publications that fall into the research area of arthroscopy but are not referred to as arthroscopy. Moreover, the time limit led to an exclusion of pioneer work before 1945 [5,12,30]. Affiliations to nations are determined by the nationality of the first author, possibly reducing multicenter studies to this one nation.

CONCLUSIONS

The growing number of knee and hip arthroscopies is reflected in the steadily increasing number of publications. Measured by the H-index and number of publications, K-ASC was the most flourishing research area overall. In the last ten to five years, interest has shifted towards H-ASC with more publications and a higher rate of citations each year. The USA plays a leading role in this research, particularly in the field of H-ASC.

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