

Bibliometric Analysis of Orthopedic Literature on Total Knee Arthroplasty in Asian Countries: A 10-year Analysis

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Purpose: We aimed to determine the quantity and quality of research output of selected Asian countries in the field of total knee arthroplasty (TKA) in the last 10 years.

Materials and Methods: Top 15 Asian countries were selected according to their gross domestic product. The Science Citation Index Expanded database was used to search for the literature published between 2004 and 2013 using "Total Knee Arthroplasty". The numbers of articles, journals and citations and the contribution of each country were analyzed. The articles were classified according to the type of study and the relative proportion of each type was analyzed.

Results: Asian surgeons have increasingly contributed to orthopedic literature on TKA for the past 10 years, but the dominant contribution came from only a few countries. The total number of articles published by Asian countries increased by 261%, with Japan producing most of the studies and China showing the maximum growth rate. The majority of studies were published in low impact factor journals. Korea published the highest proportion of articles in high impact factor journals. Clinical papers were most frequent.

Conclusions: Our identification of research productivity pertaining to TKA among Asian countries gives a unique insight into the level of academic research in the field of TKA in these countries. There is a need to improve the quality of research to enhance the publishing power in high impact journals as well as the need for more basic research and epidemiological studies considering the unique differences among Asian patients undergoing TKA.

Keywords: Knee, Arthroplasty, Bibliometric analysis, Asia

Introduction

Asia, being the largest continent in the world, is also home to the largest proportion of world population. Life expectancy is on the rise not only in the developed nations but also in many de-

veloping Asian countries¹. This places a huge burden of degenerative disorders on the healthcare system in those countries². Additionally, the activity levels of the elderly are also increasing. Thus, the importance of management of morbidity of knee osteoarthritis in terms of restricted mobility cannot be overemphasized³. Total knee arthroplasty (TKA) has revolutionized the treatment of arthritis of the knee. It addresses the issues of pain and mobility impairment in patients suffering from arthritis. The number of TKA performed in Asian countries has been steadily increasing over the past decade^{4,5}.

However, Asian patients differ from their western counterparts in many aspects related to TKA including expectations, economic variables, knee anatomy, outcomes and satisfaction⁶. Also, Asian patients tend to place higher demand on their replaced knees in the form of high flexion ground level activities^{7,8}. Western literature pertaining to TKA may not be representative of the

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Asian population, and thus the need for Asia specific literature that identifies and addresses these issues should be satisfied. Although studies pertaining to TKA in Asian population have been published, the exact quantification has not been performed.

Annually published orthopedic articles have increased from 2,889 in 2000 to 6,909 in 2009, with an average increase of 10.2% per year⁹. Similarly, there has been an increase in the number and proportion of high quality studies in orthopedic literature during this period¹⁰. It parallels the shift in strategy from eminence-based to evidence-based medicine. However, there is a wide variation in research output among nations. Global and regional bibliometric analyses of English language journals have been done in various areas of research¹¹⁻¹⁴. Many previous bibliometric analyses have looked at the overall orthopedic literature, regardless of research fields^{9,15-21}. To the best of our knowledge, no study has looked specifically into the contribution of Asian countries to the field of TKA.

We undertook this study to determine the temporal pattern of quantity and quality of research pertaining to TKA from Asian countries with respect to the total number of publications and citations, with country-specific contribution. Using the impact factors of the journals they were published in, the distribution of research quality was determined. We also aimed to document the type of published research papers. We hypothesized that Asian surgeons have increasingly contributed to orthopedic literature pertaining to TKA for the past 10 years but only a few countries have made dominant contribution, and the majority of publications were made in low impact factor journals. It was also hypothesized that clinical papers were most frequent but basic research was limited in number.

Materials and Methods

Institutional Review Board approval was waived because this study did not involve human subjects.

1. Subjects and Study Design

To analyze research volume and productivity of Asian countries in the field of TKA in the last 10 years, 1,780 articles in 173 journals were reviewed. Among those, 963 articles in 122 journals were excluded for the following reasons: different themes from TKA (782 articles in 89 journals); articles by non-orthopedic surgeons (142 articles in 22 journals); and articles using data belonging to western institutions (39 articles in 11 journals). Ultimately, 817 articles in 51 journals were included in this study.

2. Data Collection

We used the Science Citation Index Expanded (SCIE) database accessed through Web of Science (Thomson Reuters, Philadelphia, PA, USA) for this study. A computerized literature search was carried out using the database on December 31st, 2013. Top 15 countries in Asia were selected based on their gross domestic product (GDP) in 2012²². The selected countries were as follows: China, Japan, India, Korea, Indonesia, Turkey, Taiwan, Saudi Arabia, Iran, Thailand, United Arab Emirates, Malaysia, Singapore, Hong Kong, and Philippines. We used the following search terms: "Total Knee Arthroplasty" as topic, "Name of Country" as address, and "2004–2013" as publication year. TKA was used as a topic rather than title because some articles have TKA in their title which would otherwise be missed during the search. Thus, we tried to access all the articles related to primary TKA and revision TKA. We defined the country of origin as the country of the corresponding author who is primarily responsible for the study project and handles the pre and post publication communication, if any. As the SCIE database indexes addresses of all authors of a particular study, we manually classified the articles based on the country of origin of the corresponding author and assigned each article only to one country.

Only original articles, case reports, and review articles were included in this study. This was because only original articles and case reports are considered as source items and are most frequently cited. Letter to editor, editorial materials, proceedings paper, meeting abstracts, and notes were excluded. To filter research published by orthopedic surgeons, we selected journals in the fields of orthopedics, surgery, and sports sciences. This excluded studies published in non-surgical journals. The yielded results were manually checked for the abstract by two authors independently. Fifty randomly selected articles were reviewed by these authors to determine the accuracy of their interpretation and detect any inter-observer differences with regard to the title, abstract, study design, study type, address of corresponding author and the publication journal. The search results of these authors were analyzed for agreement at the end of search process. The selected studies were marked and their citations were generated using the SCIE function of citation analysis. We calculated the average citation per article from each country by dividing the number of citations during the ten year period by the number of articles published in a country during that period. The number of studies and citations were then converted into an Excel spreadsheet (Microsoft Corp., Redmond, WA, USA). To compare the proportion of Asian literature to the total world-wide literature on TKA during the same period, we searched the total number of studies

on TKA using the same search parameters without specifying the country. The results that were extracted were checked for the title and abstract, although they were not classified according to the author's address or type of study.

To analyze the trends in publication, we divided the 10-year study period into two equal parts of 5 years each: 2004–2008 (first period) and 2009–2013 (second period). The impact factors of each orthopedic journal indexed in SCIE were retrieved from the Web of Knowledge-Journal Citation Reports (JCR, Thomson Reuters). We divided the journals into high and low impact factor journals based on an arbitrary value of 2.5 (5-year impact factors based on the Thomson Reuters JCR database were obtained from JCR 2012). Journals having an impact factor above this value were termed as high impact journals (10 journals: *Annals of the Rheumatic Diseases*, *Osteoarthritis and Cartilage*, *Rheumatology*, *Journal of Bone and Joint Surgery*, *Journal of Orthopaedic Research*, *Clinical Orthopaedics and Related Research*, *Acta Orthopaedica*, *Bone and Joint Journal*, *Knee Surgery Sports Traumatology Arthroscopy*, and *Clinical and Experimental Rheumatology*) and journals with an impact factor below this value were termed as low impact journals. We further analyzed the type of study published during this period from the selected Asian countries.

Studies were classified as clinical research, basic research, and epidemiological research by consensus of the two authors²³. Clinical research included therapeutic, prognostic, and diagnostic articles and outcome studies. Basic research included anatomical and biomechanical studies, animal experiments, cell studies, and biochemical and physiological investigations. Articles describing population-based studies were classified as epidemiological research.

Table 1. Number of Articles Pertaining to Total Knee Arthroplasty Published by Asian Orthopedic Surgeons in Science Citation Index Expanded Database

Year	No. of articles
2004	36
2005	50
2006	37
2007	58
2008	69
2009	98
2010	76
2011	125
2012	138
2013	130

3. Statistical Method

All statistical analyses were conducted with SPSS ver. 18.0 (SPSS Inc., Chicago, IL, USA), and p-values < 0.05 were considered significant. For comparison between the two time periods, the proportion of publications based on the impact factor and the proportion of Asian studies to global studies were cross-tabulated. The statistical significance was determined using Chi-square test.

Results

1. Research Productivity

The number of articles on TKA published in the selected Asian countries increased from 36 articles in 12 journals in 2004 to 130 articles in 18 journals in 2013 (Table 1). Thus, there was an increase of 261%, an average of 26% per year. The highest growth in the number of articles was recorded in 2011. This increase in the number of articles published was consistent except in 2006, 2010, and 2013 (Fig. 1).

2. Temporal Trends in Research Production

With regard to the 5-year trends, the articles published in 2004–2008 were 250 and more than doubled to 567 in 2009–2013 (Table 2). Between the two 5-year periods, China showed the maximum growth rate in the number of articles published at 843%, followed by Thailand (650%), India (267%) and Singapore (186%); while Hong Kong, Saudi Arabia, and Philippines showed a decrease in published literature between the two periods. In comparison to the world literature on TKA during this period, Asian countries contributed 250 (18%) of the total 1,316 articles published during 2004–2008 and 567 (30%) of the total 1,885 articles during 2009–2013. Thus, Asian countries had a significant growth of contribu-

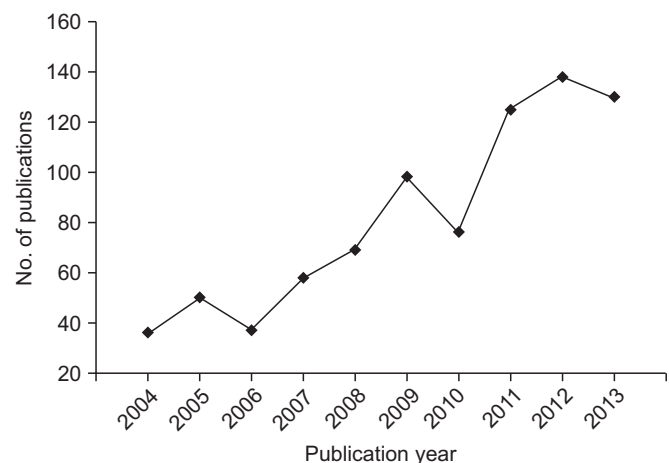


Fig. 1. Temporal pattern of research output related to total knee arthroplasty from Asia between 2004 and 2013.

Table 2. Distribution among Asian Countries of Articles Pertaining to Total Knee Arthroplasty Published in the Two Time Periods and Their Growth Rate

Country	No. of articles		Growth rate (%)
	Time period 1 (2004-2008)	Time period 2 (2009-2013)	
Japan	97	169	74
Korea	63	168	167
China	7	66	843
India	15	55	267
Taiwan	26	35	36
Turkey	13	34	162
Singapore	7	20	186
Hong Kong	17	2	-88
Thailand	2	15	650
Malaysia	1	1	0
Iran	0	2	-
Saudi Arabia	1	0	-
Philippines	1	0	-

Table 3. Total and Average Citation in Individual Countries

Country	No. of articles	No. of times cited	Average citation per article
Japan	266	1651	6.21
Korea	231	1726	7.47
China	73	318	4.36
India	70	314	4.49
Taiwan	61	552	9.05
Turkey	47	121	2.57
Singapore	27	255	9.44
Hong Kong	19	219	11.53
Thailand	2	61	3.59
Malaysia	2	37	18.50
Iran	2	2	1.00
Philippines	1	5	5.00
Saudi Arabia	1	1	1.00

tion to the literature on TKA during this period ($p < 0.001$).

3. Research Quality

On the analysis of citation, Malaysia had the highest average citation per article (18.5) followed by Hong Kong (11.53) and Singapore (9.44) (Table 3). However, Korea had the highest average citation among the top three publishing countries. Most of the Asian studies pertaining to TKA were published in sub-specialty

Table 4. Top 10 Journals Ranked according to the Number of Articles Pertaining to Total Knee Arthroplasty Published by Asian Orthopedic Surgeons (2004–2013)

Journal	No. of publication (%)
Journal of Arthroplasty	196 (24)
Knee Surgery Sports Traumatology Arthroscopy	114 (14)
Clinical Orthopaedics and Related Research	64 (8)
Bone And Joint Journal	52 (6)
Knee	52 (6)
International Orthopaedics	44 (5)
Journal of Orthopaedic Science	41 (5)
Orthopedics	40 (5)
Journal of Bone and Joint Surgery	33 (4)
Archives of Orthopaedic and Trauma Surgery	27 (3)

Table 5. Proportion of Articles Published in High Impact Journals (IF>2.5)

Country	Proportion of articles (%)		p-value
	Time period 1 (2004-2008)	Time period 2 (2009-2013)	
Korea	49	51	0.667
Japan	34	35	0.832
China	14	29	0.373
Taiwan	35	43	0.383
India	27	9	0.144
Singapore	14	40	0.020
Hong Kong	24	50	0.937
Turkey	23	12	0.330
Thailand	50	27	0.541
Malaysia	-	0	-
Iran	-	50	-
Philippines	0	-	-
Saudi Arabia	0	-	-
Total ^{a)}	35	36	0.868

IF: impact factor (5-year impact factor as of 2012).

^{a)}Total proportion of articles pertaining to total knee arthroplasty published by Asian orthopedic surgeons in high impact journals.

specific journal followed by knee joint specific journal (Table 4). Korea published the highest proportion of papers in high impact journals (impact factor > 2.5) during both time periods (Table 5). Only India, Turkey, and Thailand showed a decrease in the proportion of studies published in high impact journals between the two periods; however, the overall percentage of studies published

in high impact journals did not differ significantly between the two periods ($p=0.86$).

4. Type of Study

On the analysis of the type of studies, the majority of the studies were clinical research (84%) followed by basic science (15%). Epidemiological studies constituted the least proportion (1%).

Discussion

Bibliometrics is a set of methods to quantitatively analyze academic literature^{18,24}. Citation analysis and content analysis are commonly used bibliometric parameters. It can be a yardstick to assess the academic achievements of a country, institutions as well as individuals and can be used as a measure for their appraisal²⁵. Research dedicated to specific disease conditions in a certain geographical area can help greatly to understand the demographics, disease dynamics, and treatment options within that particular area.

The results of the present study must be viewed in the light of the following limitations. Firstly, we did not include all the Asian countries in the study. We selected certain countries according to their GDP in 2012; therefore, publications of other Asian countries excluded due to GDP were not accounted for in the present study. Secondly, we specified the fields of research as orthopedics, surgery, and sports sciences. Thus, studies published in multidisciplinary medical journals were not included in our analysis. Lastly, we divided the journals based on their impact factors released by JCR. However, Thomson Reuters states that the primary utility of the JCR is to assist librarians and researchers in selecting and managing journal collections. It acknowledges that the use of impact factor has been extended to evaluating academic work; however, it states that whilst the impact factor may give an approximation of the prestige of a journal, it should not be used in isolation²⁶. Although, the journal impact factor is commonly used in bibliometric analysis, its use for this purpose has been criticized by some authors^{27,28}.

The literature on TKA from Asian countries increased almost fourfold in the last 10 years. Previously published bibliometric analyses have shown similar results^{9,11}. Similarly, the number of published journals also increased by 50% in the same period. This may be attributed not only to the wider reach of Asian articles but also to the emergence of domestic journals among the Asian countries²⁹. The number of articles published each year has been increasing steadily except in 2006, 2010, and 2013 in which there was a decrease in the number of articles published.

Japan, Korea, and China ranked first three in the absolute number of articles published during this period. All the selected Asian countries except Hong Kong, Malaysia, Saudi Arabia, and Philippines showed an increase in the number of articles published in the two study periods. However, China showed the maximum growth rate among all the countries. Similar results have been found on analysis of general clinical research in China³⁰. The share of TKA literature of Asian countries increased from 18% in the first period to 30% in the second period. Thus, Asian countries contributed significantly to the world literature on TKA especially during the second period. This is remarkable considering none of the selected Asian countries have English as an official language except Singapore where it is one of the four official languages. The increase in the number of primary and revision TKAs, greater penetration of English language in training, and increased research funding may be responsible for this finding³¹. An analysis of global orthopedic literature published from 2000 to 2011 found Japan to be the fourth and Korea to be the tenth among all the countries in the world¹⁶. Citation analysis continues to be used as a measure of quality of articles as well as journals. Citation of an article implies its acknowledgement by peers and contribution to the scientific knowledge. Malaysia had the highest average citation among Asian countries; however, the total number of articles was only two. In contrast, among the top three publishing countries, Korea had the highest average citation. This coupled with higher proportion of articles published in high impact journals indicates consistently good quality, frequently cited research originating from Korea.

Although Japan leads the Asian countries in terms of the maximum number of articles published, Korea published the maximum proportion of articles in high impact journals during the both study periods. It is possible that some of the Japanese studies were published in domestic journals classified as low impact in the present study. Interestingly, in spite of China showing the maximum growth rate (843%) in the number of articles published, its relative proportion of publications in high impact journals only increased twofold during the second period.

On the analysis of the type of study, the most common type was clinical research, followed by basic research. Interestingly, epidemiological research constituted only 1% of the total research output. Thus, there is a higher need for epidemiological research on TKA from Asian countries especially considering the differences that exist in Asian population.

Conclusions

To conclude, Asian countries have contributed significantly to the TKA literature and its share has been increasing every year; both in terms of quantity and quality of research. However, there is a need to improve the quality of research to enhance the publishing power in high impact journals as well as the need for more basic research and epidemiological studies considering the unique differences among Asian patients undergoing TKA.

Conflict of Interest

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

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