

The Top 50 most-cited articles on Total Ankle Arthroplasty: A bibliometric analysis

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Abstract

Total Ankle Arthroplasty (TAA) is a relatively new and evolving field in Foot and Ankle surgery. We conducted a citation analysis to identify the characteristics of the top 50 most cited articles on total ankle arthroplasty. Using the Web of Science database and the search strategy *total ankle arthroplasty* OR *total ankle replacement*, we identified 2445 articles. After filtering for relevant articles, the top 50 cited articles on total ankle arthroplasty were retrieved for descriptive and statistical analysis. The publication years ranged from 1979 to 2013. USA was the most productive country in terms of research output, followed by the UK. Though citation analysis has its flaws, this is a comprehensive list of the top 50 articles significantly impacting literature on total ankle arthroplasty. Based on our study, we conclude that there is marked deficiency of high level articles with respect to the number of citations and future researches need to cater to this question to produce high quality studies.

Introduction

Total Ankle Arthroplasty (TAA) or Total Ankle Replacement (TAR) is one of the mainstay treatments for the management of primary and secondary (post-traumatic) ankle osteoarthritis. Owing to its principle of preserving ankle Range of Motion (ROM) in contrast to the alternative (Ankle arthrodesis/AA), this treatment was introduced in an effort to enable a much active and healthy lifestyle for patients postoperatively. Its use has become popular as it offers a relatively better outcome as compared to its other treatment alternative, ankle arthrodesis, owing to its principle of preserving the ankle range of motion (ROM) which allows patients to continue a much healthier and active lifestyle.¹ However, majority of the evidence is at best conflicted and thus studies have concluded

that the decision to proceed with TAA or ankle arthrodesis should be made on an individual patient basis.²⁻⁵

The popularity of TAA spiked in the 1970s when doctors realized that a treatment was required which would not restrict functional movement to a great degree as was the case in the process of ankle arthrodesis. The very first study was published in 1973 involving the use of a TAA prosthesis.⁶ Following this, along with the creation/formation of newer prostheses (termed as first-generation), emerged a series of inconsistent results associated with the use of these implants.⁶⁻¹⁰ Since the older prostheses involved use of cement fixing, it was not a surprise that complications such as loosening and osteolysis were seen in patients with first generation TAAs

Discouraging results from the first generation prostheses lead to the development of second generation prostheses (STAR™, Agility) and third generation (HINTEGRA™).¹¹⁻¹³

These so far have had promising mid-term and long-term outcomes.^{14,15}

With this aspect of orthopaedics continuing to evolve, there is a dire need to identify landmark articles for future foot and ankle surgeons to review. This would expand both knowledge and historical evolution of these prostheses. Bibliometric analysis is a burgeoning methodology within academic research, catered towards identifying and retrieving useful characteristics of most cited articles in a given research field. Previously, orthopaedic research has utilized bibliometric analyses pertaining to knee surgery,¹⁶ hip surgery,¹⁷ sports medicine¹⁸ and spine surgery.¹⁹ With respect to foot and ankle literature, only few citation analyses have been done to identify important articles in the field of foot and ankle on the whole.^{20,21} Given that TAA is a relatively new, evolving and rapidly changing subspecialty, this paper seeks to identify landmark and highly cited articles in TAA to allow future researchers and doctors to better gain an understanding of what important contributions have been made to this field.

Materials and Methods

For this study, the Web of Science database was used to retrieve manuscripts in October 2017. The Web of Science database is a subscription-based database of peer-reviewed literature owned by Thompson Reuters Inc. It is the most commonly used subscription-based database for citation analysis purposes. The terms used

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to search the database for relevant articles *Total Ankle Arthroplasty* OR *Total Ankle Replacement*. The search terms were set for as *topic* rather than *title* alone, as based on past experience we have noticed that often times studies don't mention the study details in the title. A total of 2,445 articles were retrieved from the database. Articles were then sorted on the basis of the total number of citations from the highest to the lowest. Articles were further filtered to retrieve the top 50 articles relevant to our research question on the basis of a review of their title and abstract. The top 50 articles were stored in a *marked list* and exported into an excel spreadsheet. Relevant information about articles such as title, author, year of publication, total number of times it was cited/citation frequency, journal name and country of origin was also stored in an excel spreadsheet. For country of origin, the address of the corresponding author was used to define the country.

In order to adjust for the total time since publication, the citation year index (CY index) was calculated using the following

formula:

$$\text{CY index} = \frac{\text{Total number of cites}}{\text{Number of years passed since publication}}$$

The years of publication were divided into decades (1970-1979, 1980-1989 and so on). Levels of evidence were also calculated using the Journal of Bone & Joint Surgery – American guidelines which are based on the original guidelines published by the Centre of Evidence Based Medicine.²²

The Kruskal-Wallis test was used to analyse associations between i) decade of publication and number of citations and mean citation year index, ii) level of evidence and number of citations and mean citation year index. Pearson Chi-Square test was used to analyse associations between decade of publication and level of evidence. For all statistical purposes, a P-value of less than 0.05 was considered significant.

Results

A total of 50 articles were retrieved from the database. The years of publication ranged from (1979-2013). The number of citations ranged from 65 to 293 cites. All articles were cited a total of 5,608 times by 1,382 articles with an average of 112.16 cites per item. The paper with the highest citation frequency (293) was *Intermediate and long-term outcomes of Total Ankle Arthroplasty and Ankle Arthrodesis - A sys-*

tematic review of literature by Haddad *et al.* published in 2007 (Supplementary Table S1). When corrected for the time the article had been published using the CY index, the article with the highest CY index (29.30)

was still the same one.

Tables 1 and 2 shows the top 5 articles according to the total number of cites and CY index respectively.

The most influential journal with the

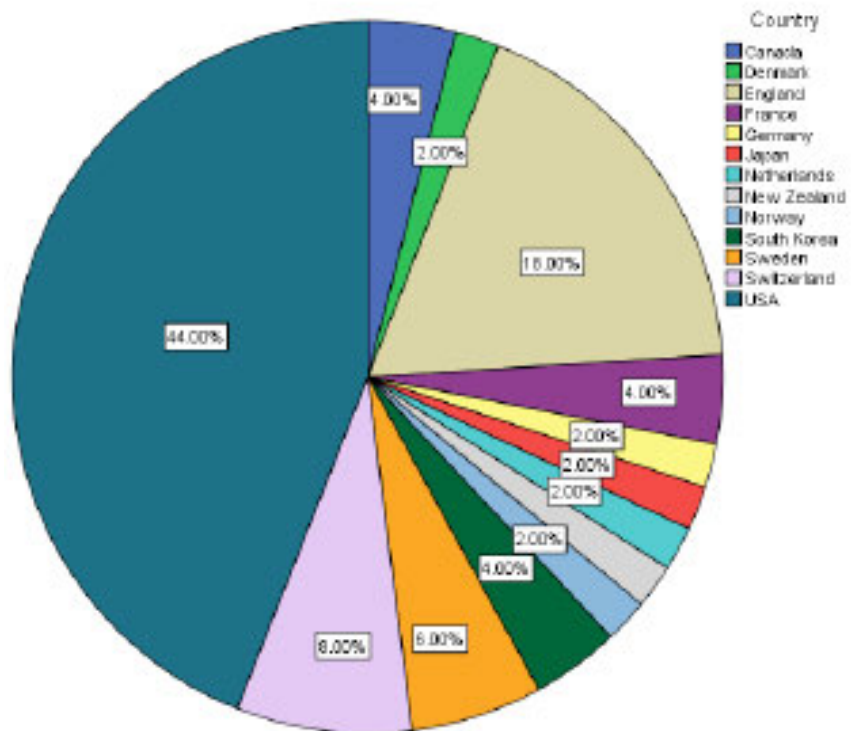


Figure 1. Worldwide productivity in the top 50 most cited list.

Table 1. Top 5 articles according to the total number of citations.

Title	Author (Year)	Total number of cites	CY index
Intermediate and long-term outcomes of total ankle arthroplasty and ankle arthrodesis - A systematic review of the literature	Haddad <i>et al.</i> (2007)	293	29.30
Total ankle replacement - The results in 200 ankles	Wood <i>et al.</i> (2003)	244	17.43
Total ankle arthroplasty: a unique design - Two to twelve-year follow-up	Pyeovich <i>et al.</i> (1998)	206	10.84
The agility total ankle arthroplasty - Seven to sixteen-year follow-up	Knecht <i>et al.</i> (2004)	205	15.77
Uncemented STAR total ankle prostheses - Three to eight-year follow-up of fifty-one consecutive ankles	Anderson <i>et al.</i> (2003)	191	13.64

Table 2. Top 5 articles after adjusting the time elapsed since publication using the CY index.

Title	Author (Year)	Total number of cites	CY index
Intermediate and long-term outcomes of total ankle arthroplasty and ankle arthrodesis - A systematic review of the literature	Haddad <i>et al.</i> (2007)	293	29.30
How Successful are Current Ankle Replacements? A Systematic Review of the Literature	Gougoulias <i>et al.</i> (2010)	183	26.14
Prospective Controlled Trial of STAR Total Ankle Replacement Versus Ankle Fusion: Initial Results	Saltzman <i>et al.</i> (2009)	162	20.25
Total ankle replacement - The results in 200 ankles	Wood <i>et al.</i> (2003)	244	17.43
The outcome of total ankle replacement. A systematic review and meta-analysis	Zaidi <i>et al.</i> (2013)	67	16.75

highest number of publications (N=12) was *Journal of Bone & Joint Surgery – American (JBJS-Am)* followed by *Clinical Orthopaedics & Related Research* (N=9) and *Foot & Ankle International* (N=9) (Table 3).

The decade with the highest number of publications was 2000-2009 with 36 articles (Table 4). The greatest number of articles (N=8) were published in 2004.

The most influential author in terms of the total contribution to the list was Hintermann, B. and Valderrabano V. with 5 articles each, followed by Wood PLR with 4 publications (Table 5).

The most productive country was USA with a total of 21 publications (42%) followed by England/UK with 9 publications (18%) and Switzerland with 4 publications (8%) (Figure 1).

The highest number of publications came from the University of Basel (N=4) followed by University of Calgary (N=3) and Mayo Clinic (N=2) (Table 6).

Majority of the articles were clinical articles (n=44; 88%), with the remaining being review articles. With regards to the level of evidence, majority of the studies were Level IV (74%), followed by level III (10%) and level V (8%) (Table 7).

The Kruskal Wallis test showed that there was no statistically significant association between the decade the article was published and the total number of cites (P=0.287). However, we did see a significant association showing a higher CY index for articles published in the recent decades (P=0.001). No statistically significant association was found between the level of evidence and the total number of cites or the CY index. Chi-Square test also showed no association between the decade of publication and the level of evidence of the article (P=0.990).

Discussion

Given the speed of technological advancement and the mushrooming of new literature indexing databases, it is not uncommon to find researchers missing important landmark articles in their citations when investigating a topic. Past studies have proposed this is because often times people either tend to cite newer articles in the field or are not well versed in conducting literature search, which results in missing out on major past findings. With a shift towards publishing reviews in order to consolidate findings of the past century, people tend to cite reviews more often than original articles themselves.²³ This ultimate-

ly results in information being lost through time as though these reviews are an effective way of presenting decades of research in a short compact manner, they do not allow the reader to gain a full grasp of what the research question was investigating in detail. With respect to the range of citations

we noticed that the top five papers were cited above 200 times. This is significantly less than papers published on total knee arthroplasties (Range: 287 to 2640; Median = 365).¹⁶ A possible reason to this could be that TAA is a relatively nascent field. Secondly, the amount of ankle arthroplas-

Table 3. Top 5 journals in terms of the total number of publications.

Journal Name	Number of publications
Journal of Bone & Joint Surgery - American	12
Clinical Orthopaedics & Related Research	9
Foot & Ankle International	9
Journal of Bone & Joint Surgery – British / Bone & Joint Journal	8
Acta Orthopaedica	4

Table 4. Number of publication with respect to decade.

Decade	Number of publications
1970-1979	1
1980-1989	3
1990-1999	4
2000-2009	36
2010-	6

Table 5. The top 5 most influential authors in terms of number of publications.

Author	Number of publications
Hintermann, B	4
Mann, RA	4
Valderrabano, V	4
Wood, PLR	3
Buechel, FF	3

Table 6. Top 5 institutions in terms of the number of publications. The remaining institutions either contributed with 2 or 1 publications, hence there is a lot of significant overlap.

Institution Name	Number of publications
University of Basel, Switzerland	4
University of Calgary	3
Mayo Clinic	2
New Jersey Institute of Technology	2
Slotervaart Hospital	2

Table 7. Proportions of the levels of evidence of the top 50 cited articles.

Level of Evidence	Number of publications
I	1 (2%)
II	3 (6%)
III	5 (10%)
IV	37 (74%)
V	4 (8%)

ties being done in the US annually is significantly far less than the ones being done for total knee replacements (TKRs). The annual number of primary knee replacements being performed in the US was 62 per 10,000 Medicare enrollees.²⁴ On the contrary, the annual number of ankle replacements was 0.84 cases per 100,000 patients in 2010.²⁵ This may be due to the fact that osteoarthritis (OA) preferentially affects the knees more than the ankles. Studies give support to this hypothesis by stating that only 1% of the world's population ends up with symptomatic ankle OA.²⁶ By contrast knee literature shows a 3.8% prevalence of knee osteoarthritis worldwide,²⁷ with up to 10-12% of men and women above the age of 60 being affected with symptomatic knee OA.²⁸ Since the ankle is not that common of a site to find osteoarthritis, a significant proportion of people undergo TAA secondary to other causes such as post-traumatic.²⁹ Perhaps the amount of industry funding that is received by TAA may be less than those for TKRs, hence the number of researches may also be less. Further studies need to be conducted to prove this point.

Furthermore, our findings revealed that majority of the publications came from the United States. The most likely reason for this was better resource allocation and provision of funding to allow studies to take place in a conducive environment. However, it was the European institutions who lead the race in terms of the number of high-cited articles. It appears that though TAA research is being conducted in the United States, but due to the presence of dedicated European ankle arthroplasty registers and a renowned body of researchers in Foot & Ankle surgery, certain institutions in Europe produced more papers. One of the pioneers of foot and ankle surgery, Beat Hintermann was based in the University of Basel and majority of the researches emerging from the institution were his own.

The most influential journal was the *Journal of Bone & Joint Surgery – American* (JBJS-Am). This journal has been regularly published since 1889 and is considered as the major orthopaedic journal worldwide. It would be wrong to expect subspecialized foot and ankle journals to be the most productive as major foot and ankle journals only started publishing since the last 1900s. Perhaps, a recent analysis may reveal a different trend in the type and number of articles published, especially when comparing subspecialized and broad-based journals. Recent literature has shown that high impact journals such as JBJS are inclined to publish US-based research.³⁰ That combined with the fact that high impact journals are always cited more than

low impact ones, it is probable that some bias may be present.

When adjusted for citation year index (CY index) it was observed that review articles tended to be cited more. In addition, articles published in the recent decade had a higher CY index. This is more of a researcher-biased observation as it is as a well-known fact that researchers tend to cite review articles and relatively recent research when writing manuscripts.

The most cited article *Intermediate and Long-Term Outcomes of Total Ankle Arthroplasty and Ankle Arthrodesis – A Systematic Review of the Literature* was published in 2007.⁵ A comprehensive review of 49 studies investigating whether second generation ankle replacements offer any benefit as compared to ankle arthrodesis, this article revealed that the data was sparse to come to a conclusion. We also showed the high proportion of level IV articles being cited as compared to other articles. Future researches need to target this lack of high quality studies, and aim at producing high-evidence randomized controlled trials and comparative studies to fully investigate all aspects of ankle replacements.

There are of course limitations to performing citation analysis. Firstly, only few databases currently offer the facility of bibliometric analysis. The largest, commonly used and publicly available database, Pubmed still does not hold this capability. Therefore, researchers tend to use a mix of other databases where differences in indexing may produce different total number of citations. Secondly, levels of evidence are not calculated and stored in these databases. Some journals such as the *JBJS-Am* previously introduced these levels of evidence, but for the most part researchers are left with the choice of carefully reviewing papers to find their levels of evidence individually.

Conclusions

Though citation analysis may not be perfect in its entirety, it remains the most standardized way to find the most influential and highly cited articles in a field. This study identifies the top 50 most articles in total ankle arthroplasty. Future researchers can use this data to identify landmark articles for inclusion in their knowledge and also acknowledge the contribution of prominent members of the orthopaedic society who have significantly altered the course of ankle replacements over the years. Studies like this allow us to understand the

evolution of total ankle replacements over time, and how operative techniques have been modified to influence patient outcomes.

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