A Bibliometric Analysis and Visualisation of Research Trends in Toxicity of Hip-implants

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Abstract: Hip implants are common and diversified types of metals are used for hip implants. The bibliometric analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of "Toxicity of hip-implants". All published articles related to "Toxicity of hip-implants" from "Scopus", were analyzed using the VOS viewer to develop analysis tables and visualization maps. This article had set the objective to consolidate the scientific literature regarding "Toxicity of hip-implants" and also to find out the trends related to the same. The most active journals in this research domain were the Journal of Bone and Joint Surgery. The most active country was the United States of America. The leading organization engaged in the research regarding the toxicity of hip-implants were the Rush University Medical Center of United States of America and the University of Strathclyde of Scotland. The most active authors who had made valuable contributions related to the toxicity of Hip implants were Grant M.H, Jacobs J.J, Catalani S, and Apostoli P.

Keywords: Toxicity, Hip-implants, Material engineering, Bibliometric analysis, VOS viewer,

1. Introduction

An engineered medical device to replace a missing or damaged biological structure is known as an implant. Different types of metals and materials are used to create implants. The toxicity of metal implants is a serious issue to be addressed. The safety of the material used is an important determinant while choosing implants. Material engineering and surface engineering can play a significant role in improving safety and reducing toxicity associated with metal implants. Toxicity of metal may even lead to complete failure of the implant. The toxicity of certain metal implants may lead to acute health issues in an advanced state. Wear particles from HIP implants are prone to toxicity (Madl, Liong, et al., 2015)(Madl, Kovochich, et al., 2015).

Stainless steel is often considered a safe metal for hip implants in comparison with Nickel (Fisher, 1993). The high success rate of Titanium implants with rare cases of failure and problems of toxicity resulted in the popularity of Titanium implants (Kim et al., 2019)

The issues of toxicity are also associated with various types of cobalt-chromium implants, especially hip implants had been reported (Posada et al., 2015) (Posada, Tate and Grant, 2015). Hip implant failure mainly happens due to adverse tissue responses caused by the wear and released ions from the implants. T-lymphocytes are mainly prone to adverse tissue reactions resulting in a chronic inflammatory response in cases of Cobalt-Chromium toxicity (Posada, Tate and Grant, 2015). Hypersensitivity to Nickel can be in cases of orthopedic implants or delayed hypersensitivity among patients who underwent a hip replacement. Such patients may with pain, fatigue, and contact allergic dermatitis, and instability (Delimar et al., 2018). Chances for postoperative hypernickelemia and nickeluresis should be counted in cases of the nickel-based porous-coated knee or hip prostheses is also common (Sunderman F.W. et al., 1989). Bone health may be affected by the wear of chromium ions from chromium-based hip implants and may ultimately lead to bone-related complications (Andrews et al., 2011). Hip-implant based on chromium had been reported as the issue of toxicity (Ng, Ebneter, and Gilhotra, 2013). Toxicity of Cobalt due to hip to hip (Dijkman et al., 2012)(Madl, Kovochich, et al., 2015)(Madl, Liong, et al., 2015)(Leyssens et al., 2020)(Leyssens et al., 2018).

This bibliometric analysis will be a useful platform for future researchers by realizing the top researchers, organizations, and countries involved in research regarding the toxicity of hip-implants. This article is arranged into four sections. The first section is the introduction, followed by the discussion of the methodology by which the research was conducted. The third section deals with results and discussion. The fourth section deals with the conclusion. The following research objectives and research questions were framed for conducting bibliometric analysis systematically.

1.1 Research Objectives

a) To consolidate the literature regarding the toxicity of hip-implants
b) To find out the trends related to research in toxicity of hip-implant

1.2 Research Questions

a) Who are the active researchers working on the toxicity of hip-implant?
b) Which are the main organizations and countries working on the toxicity of hip-implant?
c) Which are the main journals related to the toxicity of hip-implant?

2. Research Methodology

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE-ABS (Toxicity hip-implant) on 08/03/2021. All the tables in this paper were created by using Microsoft Excel and VOS Viewer. Grammarly was used for spelling and grammar checks. Mendeley was used for article review and citation. This paper had been inspired by bibliometric analysis in its presentation style, analysis, and methodology from the works (Farhat et al., 2013; Liao et al., 2016; Kolkailah et al., 2019; Rodríguez-Padial et al., 2019; Tran et al., 2019; Ullah et al., 2019; Shahid et al., 2020).

3. Results and discussion

3.1 Results

This first round of search produced an outcome of 128 documents, in five languages, out of which 121 documents were in English. The classification of document categories is shown in Figure 1. For improving the quality of the analysis, we had selected only the peer-reviewed articles and all other documents had not been considered. Thus after using filters "Article" and "English" the second round search produced an outcome of 91 English articles (both open access and others) and had been used to conduct bibliometric analysis and visualization using VOS Viewer. The English research articles in this domain since 1986 had been shown in Figure 2.

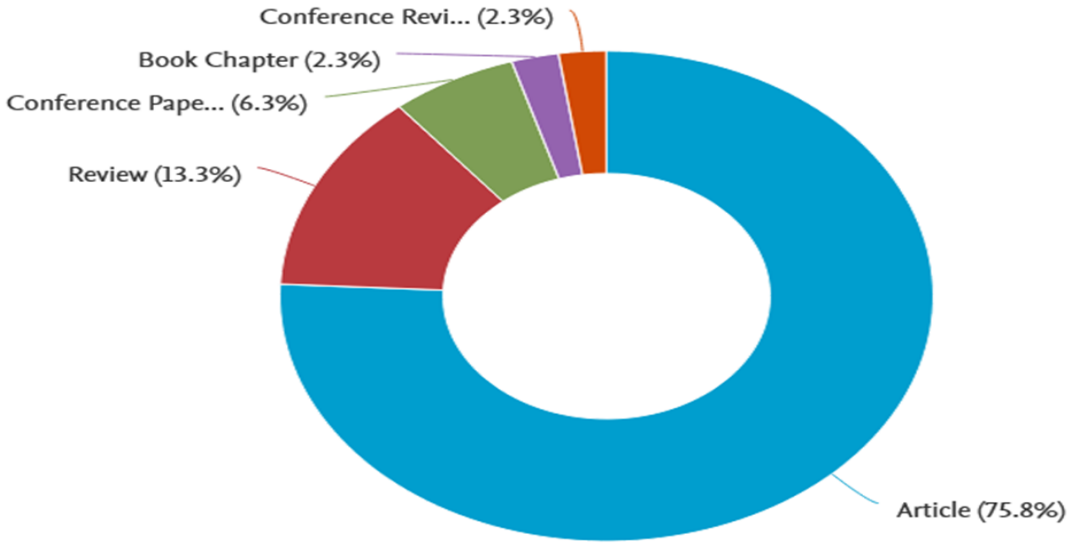

Figure 1: Classification of the documents on "Allergy of hip-implants", Source: www.scopus.com

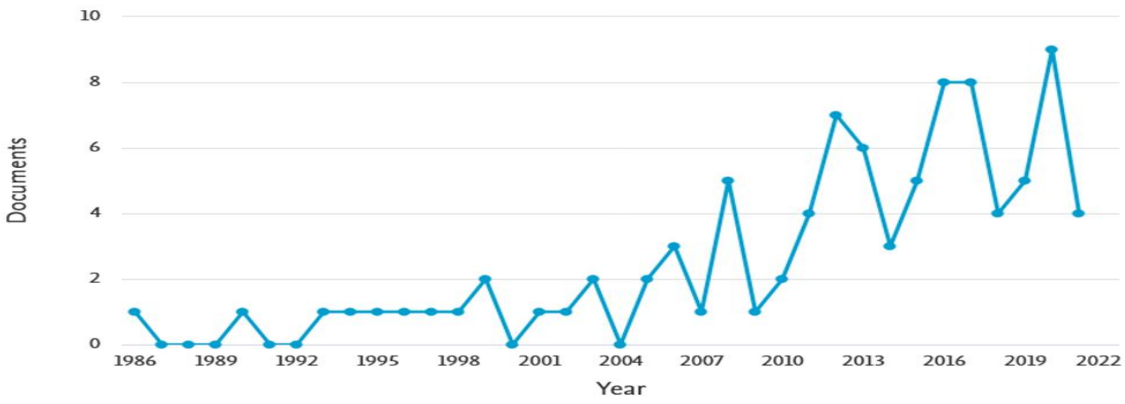

Figure 2: Period wise publication of articles, Source: WWW.scopus.com

Co-authorship analysis of top authors had been shown in figure 3. For a better presentation of the analysis, the parameters used were the minimum number of documents of an author as two and the minimum number of citations of authors as one. This combination plotted the map of 30 authors, in 13 clusters. The overlay visualization map of co-authorship analysis plotted in Figure 3, points out the major researchers with their strong co-authorship linkages and clusters involved.

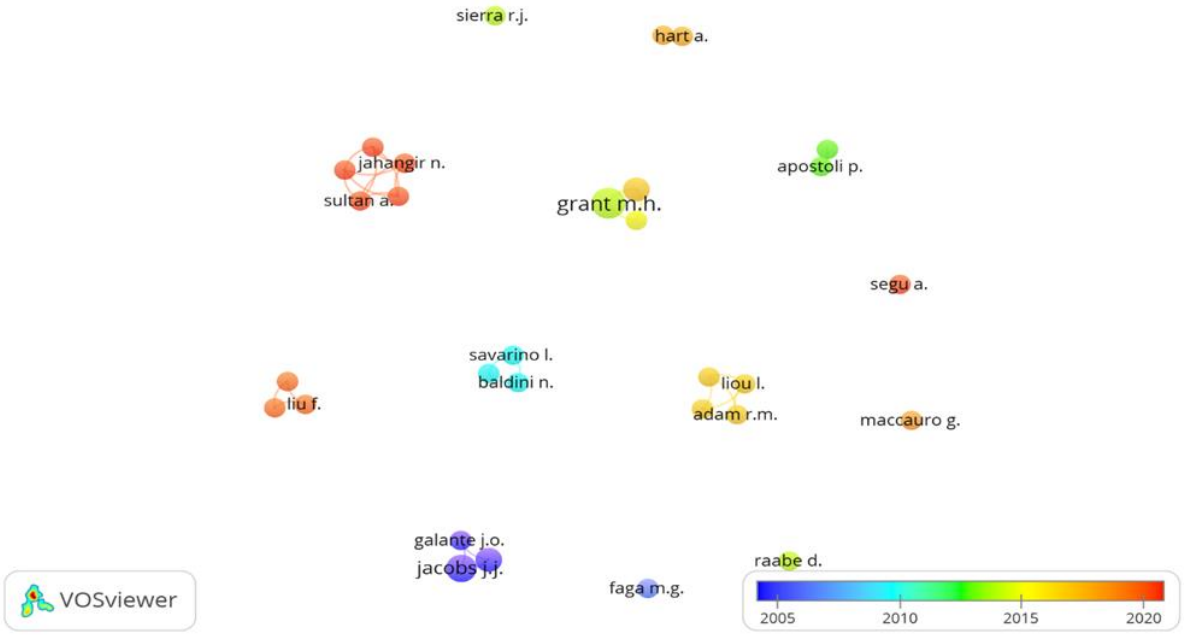

Figure 3: Co-authorship analysis on basis of authors

The citation analysis of top authors had been shown in table 1, along with co-authorship links. For the citation analysis, the parameters used were the minimum number of documents of an author as one and the minimum citations of an author as one.

Table 1: Highlights of most active authors

Description	Authors	Documents	Citations	Average citations per documents	Link strength
Leading authors on "toxicity of hip implants"	Grant M.H	5	125	25	10
	Jacobs J.J	4	898	224.5	13
	Catalani S.	2	69	34.5	18
	Apostoli P.	2	69	34.5	18

In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrences of a keyword as 10. This combination plotted the map of 28 thresholds, in three clusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Figure 4.

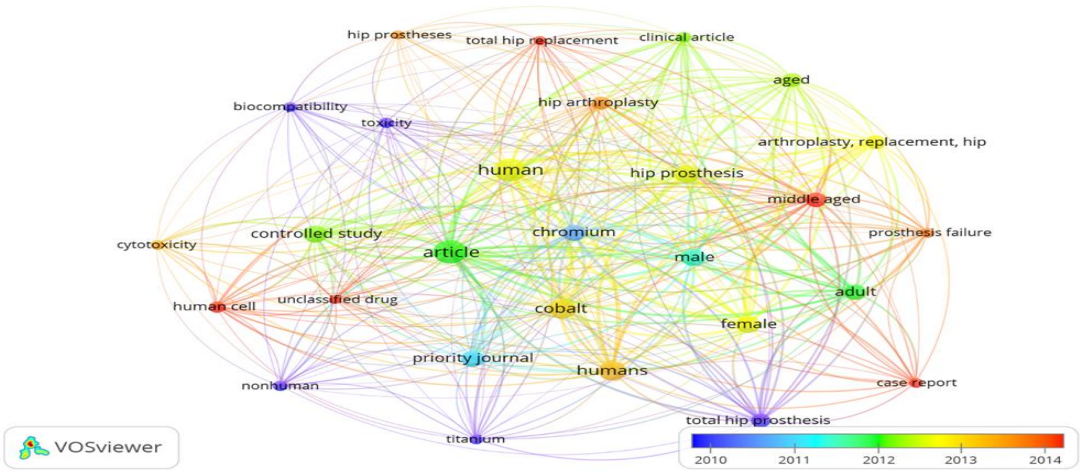

Figure 4: Co-occurrence analysis on basis of all keywords

The leading organizations engaged in research on "Toxicity on hip-implants" had been found out by the volume of publications and citation analysis, the parameters used are the minimum number of documents of an organization as one and the minimum number of citations of organizations as one. The leading organization in the research regarding "Toxicity on hip-implants", with the highest number of publications and citations, was the Rush

University Medical Center of United States of America and University of Strathclyde of Scotland (Refer to table 2).

Table 2: Highlights of the most active organization

Organizations	Country	Documents	Citations	Average Citations per document
Rush University Medical Center	United States of America	5	792	158.4
University of Strathclyde	Scotland	5	125	25

Co-authorship analysis of the countries engaged in the research on "Toxicity of hip-implants" had been shown in Figure 5. The overlay visualization map of co-authorship analysis plotted in Figure 5, points out the main countries with their strong co-authorship linkages and clusters involved.

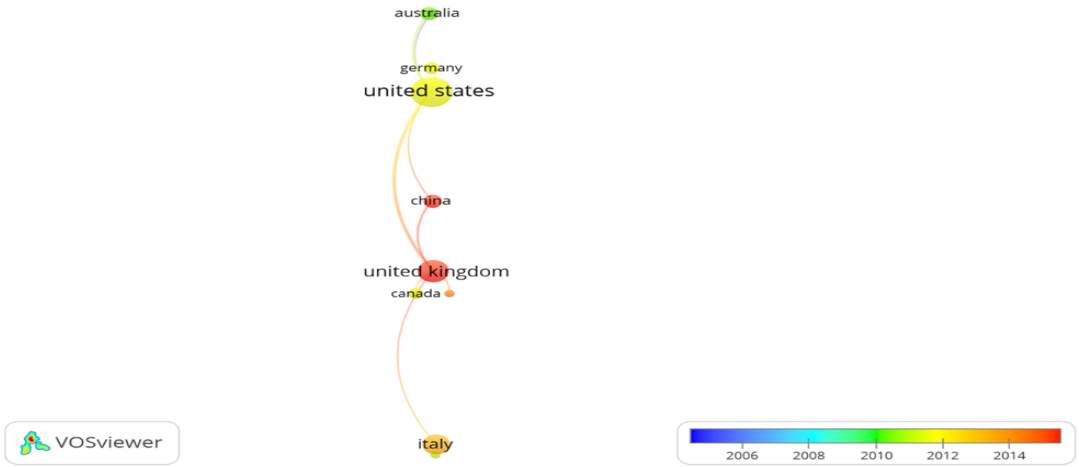

Figure 5: Co-authorship analysis on basis of countries

The citation analysis of top countries had been shown in table 3, along with co-authorship links. For the citation analysis, the parameters used were the minimum number of documents of a country as one and the minimum citations of the country as one.

Table 3: Highlights of Active Countries

Description	Country	Documents	Citations	Link strength
The country with the highest publication, citations, and co-authorship links	United States of America	30	1237	17

The most active country in this research domain was the United States of America, with the highest number of publications, citations, and co-authorship links.

Link analysis and citation analysis were used to identify the most active journal in this research domain. We have taken the parameters of the minimum number of documents of a journal as one and the minimum number of citations of a journal as one for the link analysis and citation analysis. Highlights of the most active and relevant journals related to "Toxicity of hip-implants" are shown in table 4. Table 4 shows the journal activity of this research domain through parameters of publication volume, citations, and co-authorship linkages.

Table 4: Analysis of journal activity

Description	Journal details	Documents	Citations	Average citations per documents
Journal with the highest publications, citations, and co-authorship links	Journal of Bone and Joint Surgery	03	1087	10

From the above discussion regarding the bibliometric patterns in the research regarding the toxicity of hip-implants, this research had observed a gradual increase in research interest regarding the toxicity of hip-implants from the starting of the millennium and the momentum is going on positively. This points out the relevance and

potential of this research domain (Refer to Figure 2). The most active authors in this research domain were Grant M.H, Jacobs J.J, Catalani S, and Apostoli P. with the highest publication, citations, and co-authorship links (Refer to table 1). The overlay analysis of top countries researching the toxicity of hip implants indicates that the United States of America was the leading country relating to the highest number of publications, citations, and co-authorship links (Refer to figure 5). The top journals of this research domain were identified as the Journal of Bone and Joint Surgery. From these wide sources of information, researchers can focus on top journals where they can identify the most relevant and highly cited articles regarding the toxicity of hip-implants.

4. Conclusion

Toxicity of hip-implant was an interesting research domain and the most active journals related to this research domain were the Journal of Bone and Joint Surgery. The most active country was the United States of America. The leading organization engaged in the research regarding the toxicity of hip-implants were the Rush University Medical Center of United States of America and the University of Strathclyde of Scotland. The most active authors who had made valuable contributions related to the toxicity of Hip implants were Grant M.H, Jacobs J.J, Catalani S and Apostoli P. This research domain offers a new avenue for researchers and future research can be on innovations against toxicity of hip-implants.

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