

A Bibliometric Analysis and Visualisation of Research Trends in Toxicity of Cobalt Implants

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Abstract: The toxicity of metals is a vital factor affecting the safety of implants. The bibliometric analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of “toxicity of Cobalt implants”. All published articles related to “toxicity of Cobalt 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 Cobalt implants” and also to find out the trends related to the same. The most active journal related to this research domain was the Journal of Bone and Joint Surgery. The most active country was the United States of America. The leading organization was Rush University Medical Center, United States of America. The most active authors were Hallab N. J and Jacobs J.J.

Keywords: Toxicity of implants, Cobalt implant, Material engineering, Bibliometric analysis, VOS viewer,

1. Introduction

The toxicity of metals is a serious issue associated with metal implants and the impact of toxicity may be of varying degrees to different patients (Akil et al., 2018). The toxicity of Cobalt implants may be due to corrosion, wear, and or due to hypersensitivity to the metal. Toxicity and metal hypersensitivity at an extreme stage may even lead to failure of implant or replacement of implant with a comparatively safe metal. Different types of metals and materials are used to create implants and the most popularly used metals and alloys for bio-implants are stainless steel, cobalt-chromium alloy, and Titanium (Priyanka et al., 2014). Various types of implants had been used in modern medicine and include sensory implants, neurological implants, cardiovascular implants, orthopedic implants, contraceptive implants, and cosmetic implants. According to a recent study, the toxicity and health issues associated with Cobalt implants are severe than the implants based on Titanium and Zirconium (Dalal et al., 2012). Toxicity of Cobalt implants may lead to ophthalmological issues (Ng, Ebnetter and Gilhotra, 2013) and Neuropsychiatric symptoms (Green, Griffiths and Almond, 2017). Similarly high level of Serum Cobalt concentrations due to Cobalt toxicity can also raise other health issues (Tolan, Sierra and Moyer, 2015) (Ng, Ebnetter and Gilhotra, 2013).

Despite having various advantages associated with implants, the safety of implants is an important parameter associated with acceptance. The toxicity of implants and treatments to reduce the toxicity of implants is an important matter to be addressed. Material engineering and surface engineering play a vital role in the selection and usage of safe metals and alloys as implants. Serious health issues due to corrosion and wear of metal-metal implants based on Cobalt and Chromium (Campbell and Estey, 2013) (Cobb and Schmalzreid, 2006) Implants derived Cobalt-Chromium and molybdenum (CoCrMo alloy) nanoparticle disrupts DNA replication dynamics in neuronal cells (Bijukumar et al., 2021) Toxicity and allergy due to implants based on cobalt-chromium alloys (Posada et al., 2015); (Posada, Tate and Grant, 2015).

This bibliometric analysis will be a useful platform for future researchers by realizing the top researchers, organizations, and countries involved in research regarding the hypersensitivity of Cobalt based-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 cobalt implants
- b) To find out the trends related to research in toxicity of cobalt implants

1.2 Research Questions

- a) Who are the active researchers working on the toxicity of cobalt implants?
- b) Which are the main organizations and countries working on the toxicity of cobalt implants?

c) Which are the main journals related to the toxicity of cobalt implants?

2. Research Methodology

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE-ABS-KEY (Toxicity Cobalt Implants) on 03/03/2021. 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 six languages, out of which 120 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 89 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 1984 had been shown in Figure 2.

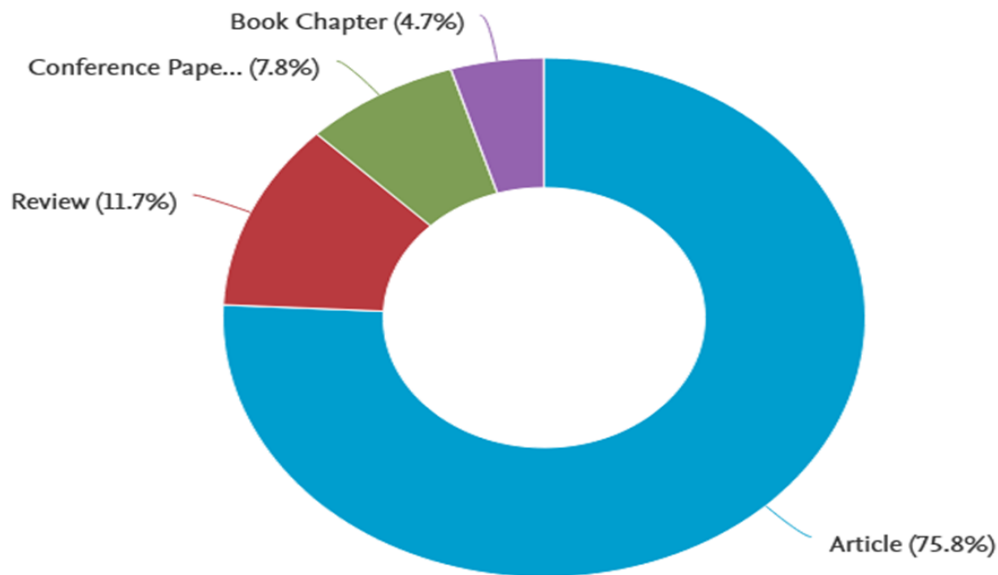


Figure 1: Classification of the documents on “Toxicity of Cobalt implants”, Source: www.scopus.com

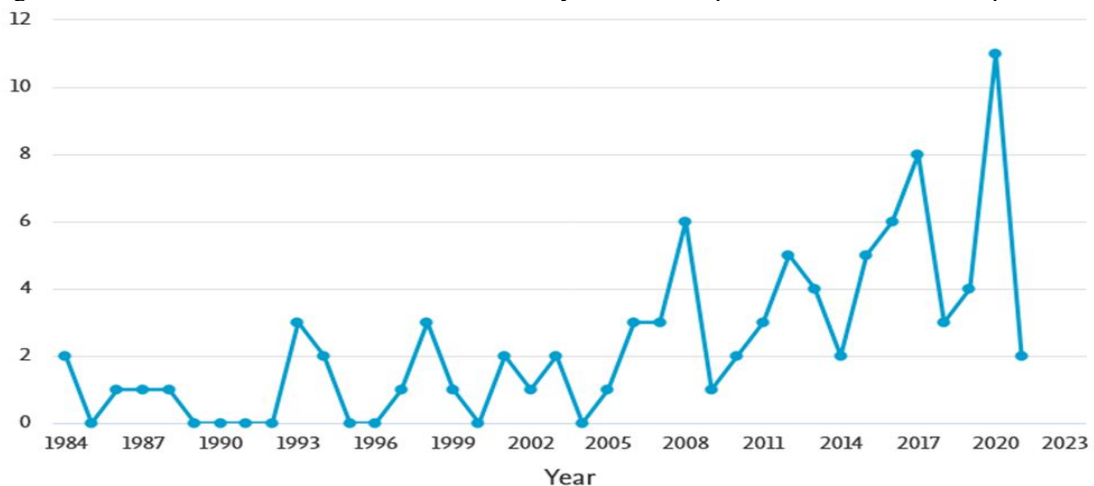


Figure 2: Period wise publication of articles, Source: WWW.scopus.com

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 40 authors, in 11 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.

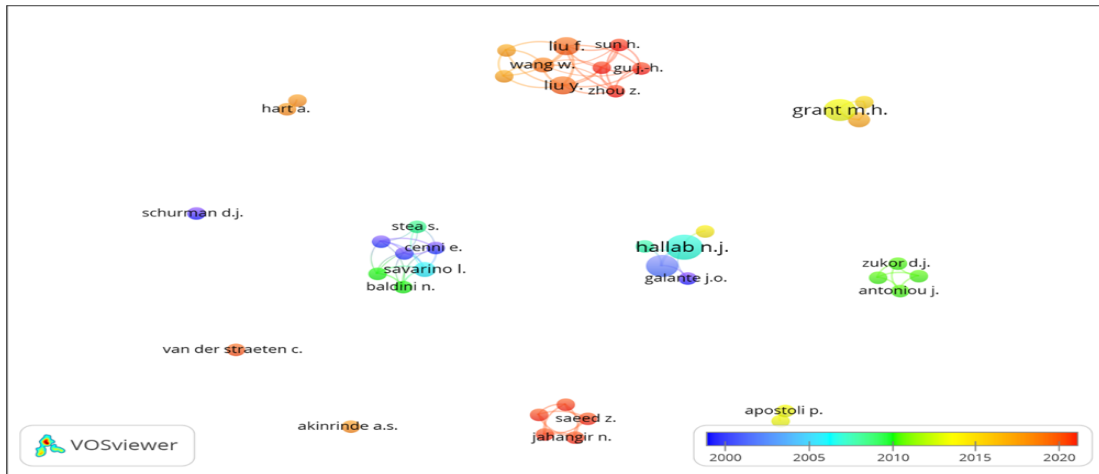


Figure 3: Co-authorship analysis on basis of authors

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
Authors with the highest publication and co-authorship links	Hallab N. J	8	904	113	27
Authors with the highest citations	Jacobs J.J	6	1072	178.6	20

In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrences of a keyword as 12. This combination plotted the map of 28 thresholds, in two clusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Figure 4.

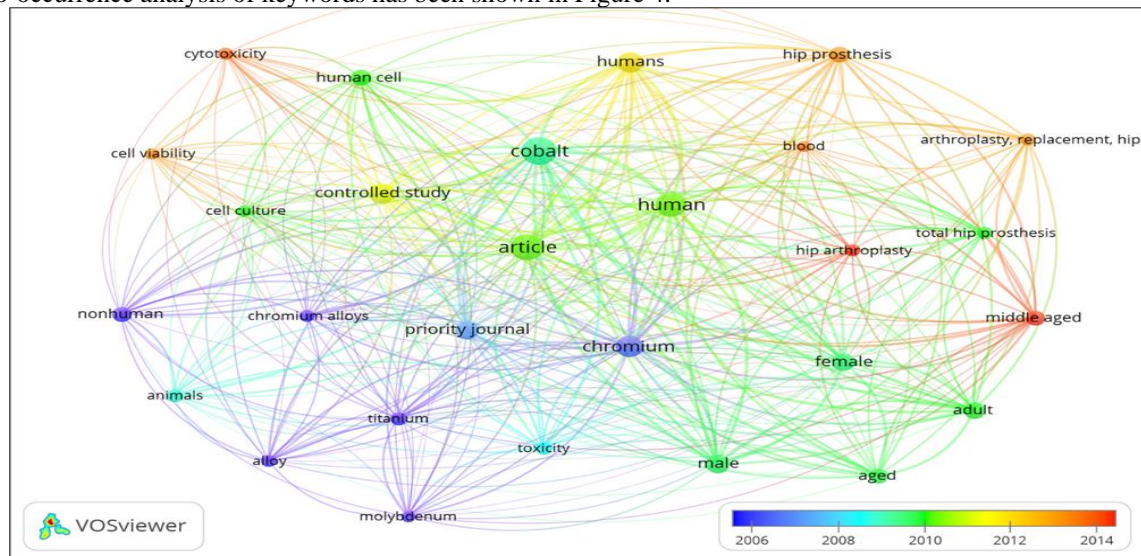


Figure 4: Co-occurrence analysis on basis of all keywords

The leading organizations engaged in research on the “toxicity of Cobalt 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 the “toxicity of Cobalt implants”, with the highest number of publications and citations, was the Rush University Medical Center, United States of America. (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	9	915	101.7

Co-authorship analysis of the countries engaged in the research on “toxicity Cobalt of 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.

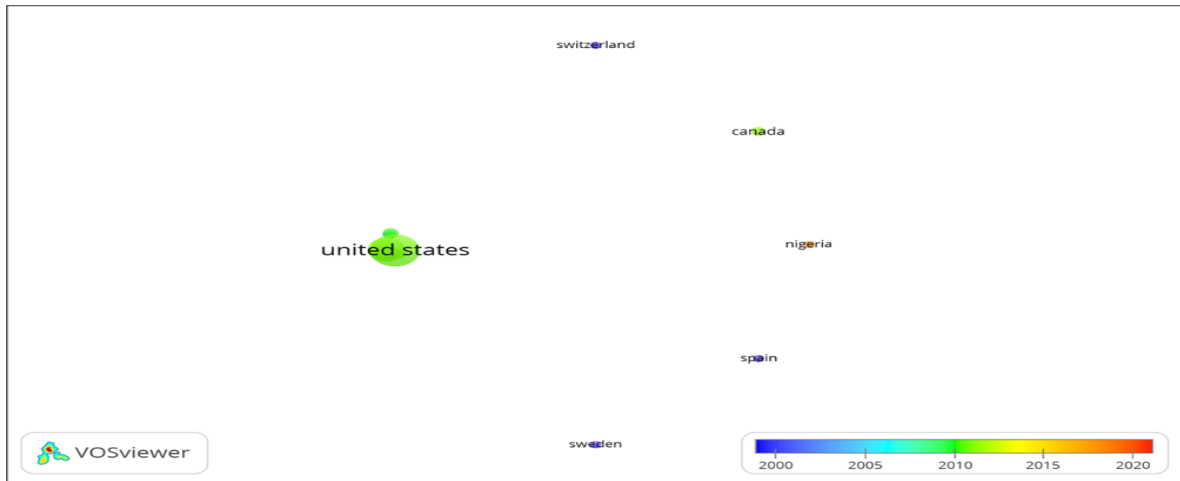


Figure 5: Co-authorship analysis on basis of countries

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, v and co-authorship links	United States of America	36	1971	10

The most active country in this research domain was the United States of America, with the highest number of publications and 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 Cobalt 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	4	1256	11

From the above discussion regarding the bibliometric patterns in the research regarding “toxicity of Cobalt implants”, this research had observed a gradual increase in research interest regarding “toxicity of Cobalt 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 Hallab N. J and Jacobs J.J. with the highest publication and co-authorship; and citation respectively (Refer to table 1). The overlay analysis of top countries researching “toxicity of Cobalt 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 journal of this research domain was identified as the Journal of Bone and Joint Surgery with the highest publication, citations, and co-authorship links. 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 Cobalt implants.

4. Conclusion

The toxicity of Cobalt implants was an interesting research domain and the most active journal related to this research domain was the Journal of Bone and Joint Surgery. The most active country was the United States of America. The leading organization was Rush University Medical Center, United States of America. The most active authors who had made valuable contributions related to the toxicity of Cobalt implants were Hallab N. J and Jacobs J.J. with the highest publication, citations, and co-authorship links. This research domain offers a new avenue for researchers and future research can be on innovations in the toxicity of Cobalt implants.

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