A Bibliometric Analysis and Visualisation of Research Trends in of Corrosion of Hip Implant

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Abstract: Innovations and advances in material engineering and surface engineering play a key role in developing modern, safe, durable, and biocompatible implants. The bibliometric analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of "corrosion of hip- implants". All published articles related to "corrosion of implants" from "Scopus", were Journal of Bone and Joint Surgery and Journal of Arthroplasty. The leading organization engaged in the research regarding surface coating of hip implants was the Rush University Medical Centre. The most active author who had made valuable contributions related to the corrosion of implants was Jacobs J.J

Keywords: Corrosion, 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 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 metals are used for hip-implants. Allergic skin disease is another issue associated with patients who underwent hip replacement with metal-on-metal (MOM) bearings. This happens due to corrosion and the release of wear debris and high levels of metal ions in the blood (Bizzotto *et al.*, 2015). Stainless steel is used for diversified implanting devices and corrosion is a serious challenge associated with stainless steel implants. Various types of surface treatments can be conducted on steel to improve its competency to be used as a material for bio-implants. Stainless steel is not having high-class anticorrosive properties (Balestriere *et al.*, 2020) and there are cases of implant failure due to corrosion of stainless steel (Pugh, Jaffe, and Jaffe, 1975). Extensive corrosion of steel was observed in femoral hip prostheses with ages ranging from eight to twenty years after implantation (Musolino *et al.*, 1996). The surface coating can be used against corrosion and wear of hip implants.

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). Titanium Hip implants can be a good choice against corrosion of hip implants. Titanium bio-implants are known for corrosion resistance, biocompatibility, and mechanical resistance (Jorge *et al.*, 2013)(Sidambe, 2014). However, Bio corrosion of Titanium implants in presence of bacteria is an issue of Titanium implants (Shah *et al.*, 2016) (Mombelli, Hashim, and Cionca, 2018)(Soler *et al.*, 2020). Carburized titanium is a solid lubricant on hip implants and can improve corrosion resistance (Cheng *et al.*, 2018). Zirconium is one of the top metals used for implantation purposes. Zirconium is used for diversified implanting devices and corrosion is a serious challenge associated with Zirconium implants.

Material engineering and surface engineering play a very important role in providing solutions to diversified issues connected with corrosion of hip-implants This bibliometric analysis will be a useful platform for future researchers by realizing the top researchers, organizations, and countries involved in research regarding the corrosion 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 corrosion of hip implants
b) To find out the trends related to research in the corrosion of hip implants

1.2 Research Questions

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

2. Research Methodology

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE-ABS (corrosion hip implants) on 27/02/2021. 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 701 documents, in ten languages, out of which 676 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 464 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 1961 had been shown in Figure 2.

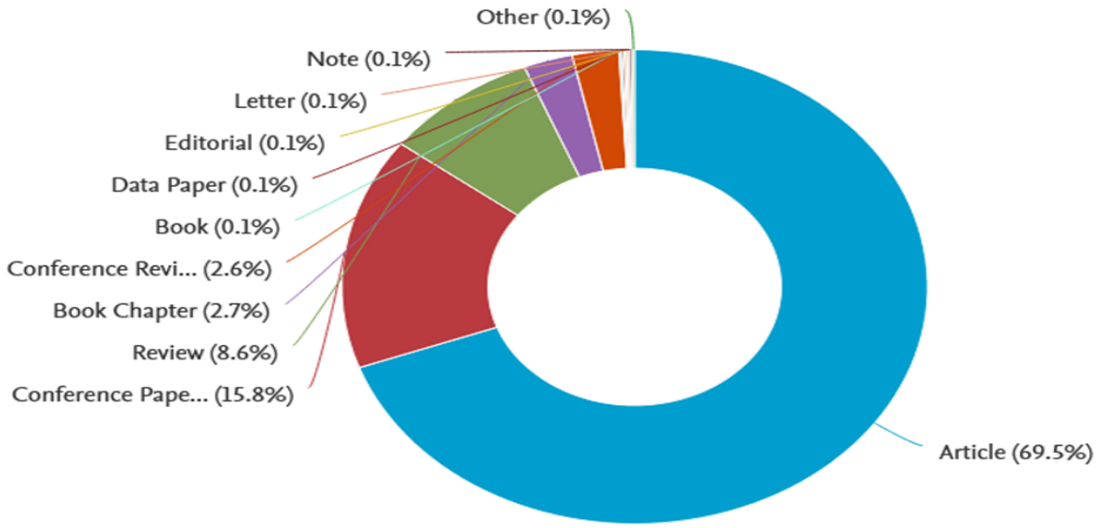

Figure 1: Classification of the documents on "corrosion of hip-implants", Source: www.scopus.com

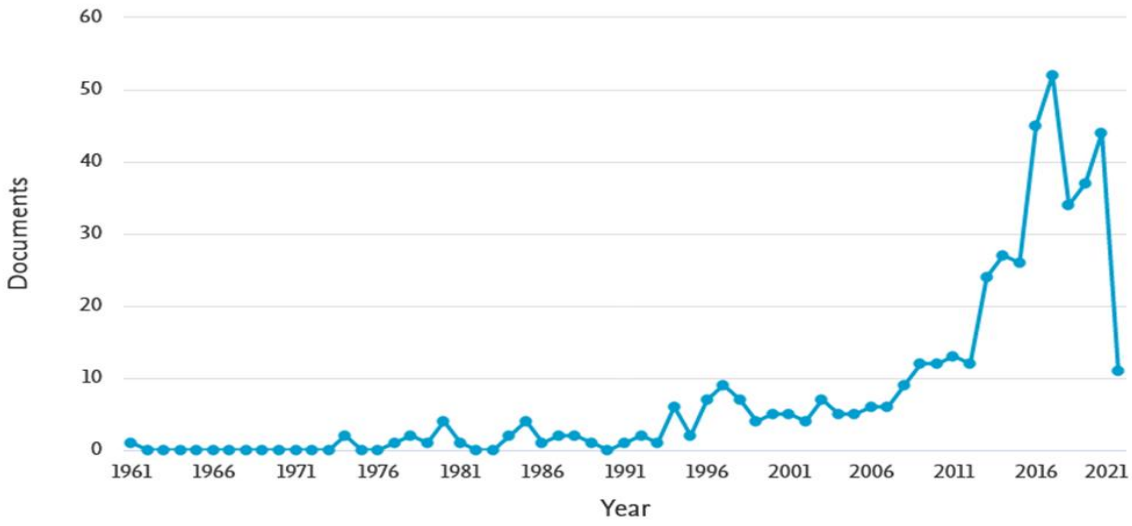

Figure 2: Period wise publication of articles, Source: WWW.scopus.com

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 five and the minimum number of citations of authors as one. This combination plotted the map of 32 authors, in 10 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.

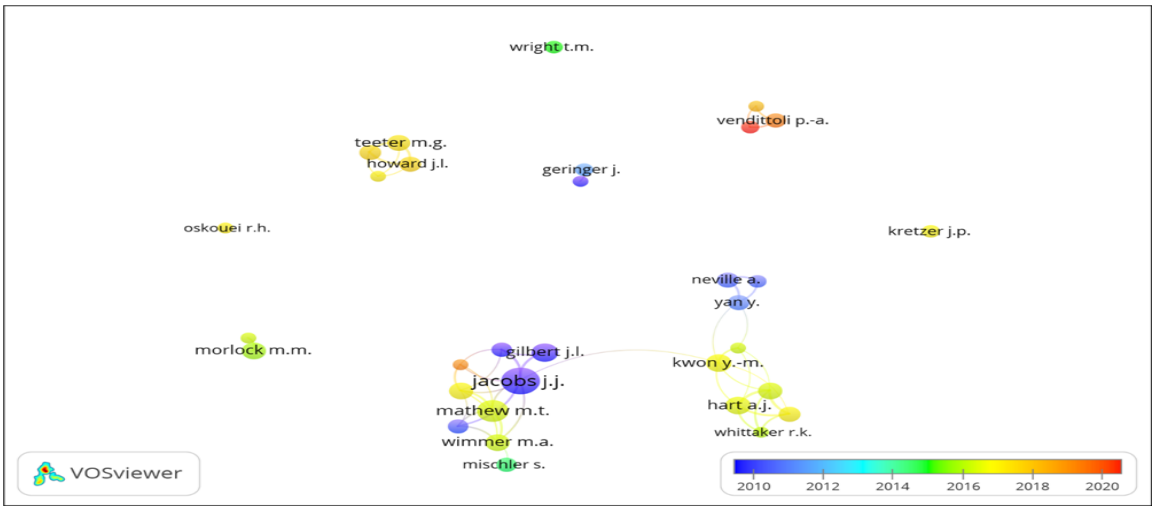

Figure 3: Co-authorship analysis on basis of authors

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, co-authorship links, and citations	Jacobs J.J	24	3467	144.4	116

In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrences of a keyword as 60. This combination plotted the map of 31 thresholds, in three clusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Figure 4.

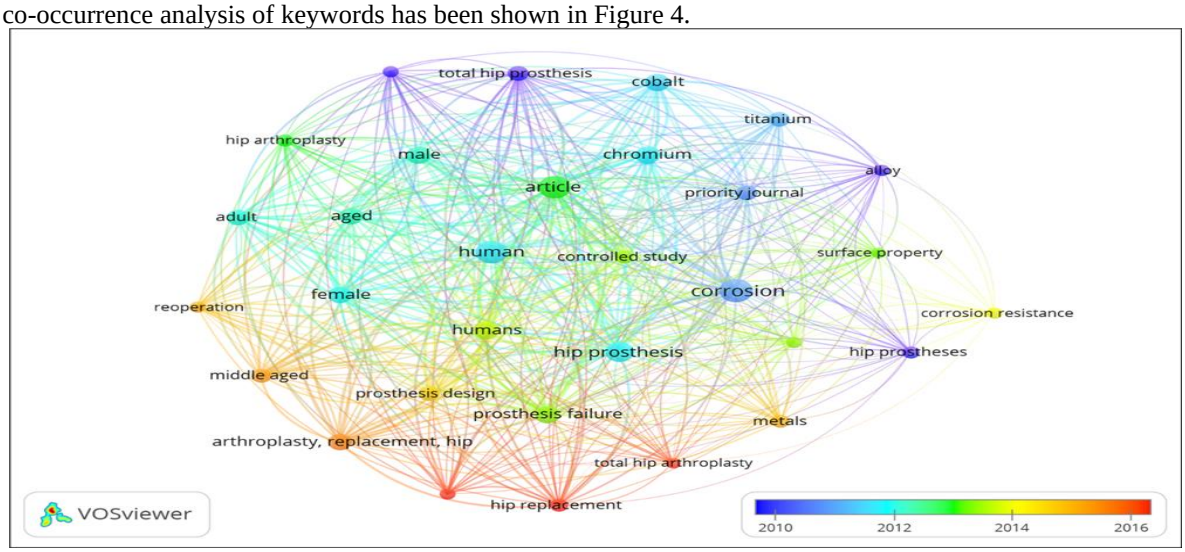

Figure 4: Co-occurrence analysis on basis of all keywords

The leading organizations engaged in research on “corrosion of 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 “corrosion of hip 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	24	196	8.1

Co-authorship analysis of the countries engaged in the research on "corrosion 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.

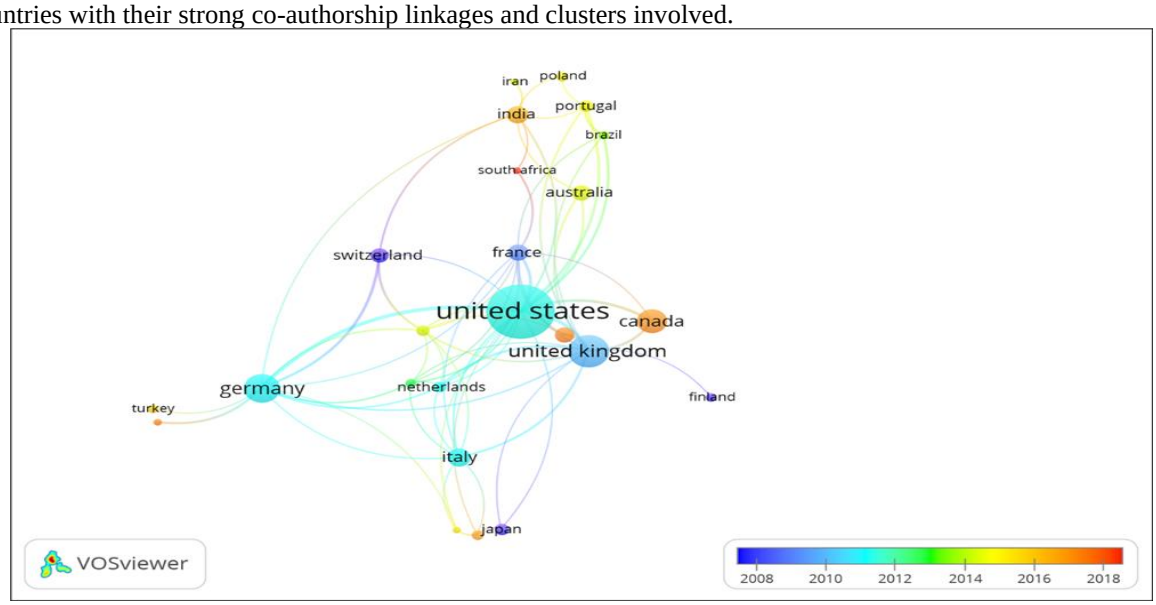

Figure 5: Co-authorship analysis on basis of countries

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	188	7321	47

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 respectively.

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 "corrosion 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	Co-authorship
Journal with the highest publications and co-authorship links	Journal of Arthroplasty	66	1448	293
Journal with the highest citations	Journal of Bone and Joint Surgery	10	2171	178

From the above discussion regarding the bibliometric patterns in the research regarding corrosion of hip implants, this research had observed a gradual increase in research interest regarding corrosion 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 author in this research domain Jacobs J.J with the highest publication, co-authorship, and citations respectively (Refer to table 1). The overlay analysis of top countries researching corrosion of hip implants indicates that 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 Arthroplasty, and 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 corrosion of hip implants.

4. Conclusion

Corrosion of hip implants was an interesting research domain and the most active journals related to this research domain were the Journal of Bone and Joint Surgery and Journal of Arthroplasty. The leading

organization engaged in the research regarding surface coating of hip implants was the Rush University Medical Centre. The most active author who had made valuable contributions related to the corrosion of implants was Jacobs J.J. This research domain offers a new avenue for researchers and future research can be on innovations in the corrosion of hip implants.

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