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Research Article

A Bibliometric Analysis and Visualisation of Research Trends in Corrosion of knee implants

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Abstract: Corrosion of metals is one of the major challenges of the performance of knee implants. The bibliometric analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of "Corrosion of knee implants". All published articles related to "Corrosion of knee 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 "Corrosion of knee implants" and also to find out the trends related to the same. The most active journals in this research domain were the Wear, and Journal of Arthroplasty. The most active countries were the United States of America and India. The leading organizations engaged in the research regarding corrosion of knee-implants were the Drexel University and Rush University Medical Center of United States of America. The most active author related to knee implants was Badar R.

Keywords: Knee implants, Corrosion, 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. Human knee joints are facing numerous problems including wear, damage, and accidents. Total knee replacement surgery can improve quality of life in cases where repair of the knee is impossible. A knee implant is placed in the knee joint in cases of total knee replacement. knee implants are often used subjected to wear and corrosion and ultimately lead to poor performance, pain, and wastage of money. Similarly, various types of surface treatments and surface coatings can be conducted on chromium knee implants to improve their competency to be used as a material for knee-implants.

Steel knee implants are often used subjected to wear and corrosion and ultimately lead to poor performance, pain, and wastage of money. Similarly, various types of surface treatments can be conducted on steel to improve its competency to be used as a material for knee-implants. As 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), various types of mechanical, chemical, and electrochemical surface preparation methods like electrolytic polishing and ultrasonic cleaning can resist the corrosion of steel implants and reduce the breakdown potential (Ahmadian, Danaee and Golozar, 2013)(Ahmadian, Danaee and Golozar, 2014)(Irving Jr., 1985). Nanocoatings can be an ideal strategy for reducing wear in steel knee implants (Shivendra Kumar, Meenakshi, and Ramana, 2019). Similarly, Sol-gel coating can enhance the anticorrosive and surface performance of stainless steel (Balestriere et al., 2020)(Ballarre et al., 2012)(Ballarre et al., 2013)(Ballarre and Ceré, 2018) Surface modification of stainless steel implants using nanostructured forsterite (Mg_2SiO_4) coating (Kheirkhah et al., 2015); Hydroxyapatite/hydroxyapatite-magnesium double-layer coatings for surface modification of stainless steel implants (Rezaei et al., 2020)(Sutha et al., 2015); phosphate interlayered hydroxyapatite coating for stainless steel implants (Shibli and Jayalekshmi, 2008). Surface coating especially the Cryogenic and Coating treatments can have a significant effect on the Wear and Friction of knee implants (Deenoi and Dechjarern, 2019). Similarly, Stem cell-coated titanium implants can be used for the partial joint resurfacing of the knee (Frosch et al., 2006).

Zirconium can be used as a femoral component material in total knee arthroplasty (TKA). Polyethylene wear is the main determinant of the long-term survival of knee implants (Heyse, Haas, and Efe, 2012). This would reduce the chances for polyethylene wear and improves the long-term survival of the implant (Innocenti et al., 2014). Significant reduction of polyethylene wear can be possible by using Oxidised Zirconium as a femoral component material (Anderson et al., 2017)(DesJardins, Burnikel, and LaBerge, 2008)(Ezzet et al., 2004)(Ezzet et al., 2012).

Future research can be on various research niches like surface coating, and corrosion-resistant technologies associated with knee implants. This bibliometric analysis will be a useful platform for future researchers by realizing the top researchers, organizations, and countries involved in research regarding bio-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 steel-implants
b) To find out the trends related to research in Corrosion of steel-implants

1.2 Research Questions

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

2. Research Methodology

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE –ABS (Corrosion Knee Implants) on 28/02/2021. 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 133 documents, in six languages, out of which 124 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 74 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 1974 had been shown in Figure 2.

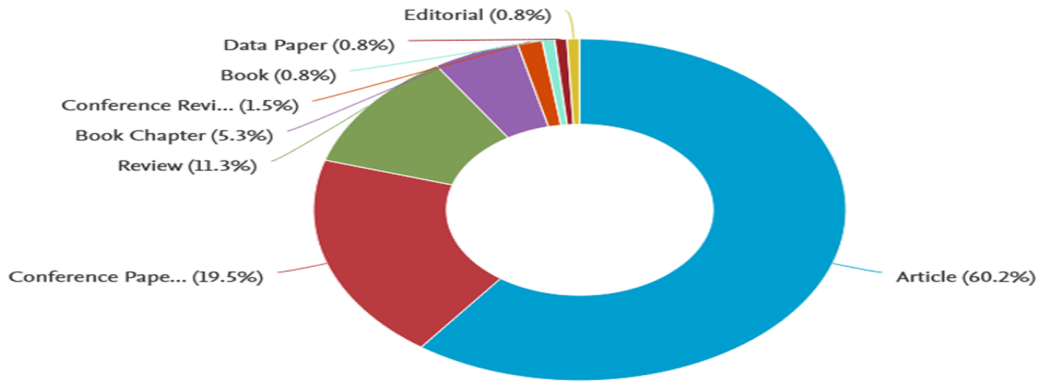

Figure 1: Classification of the documents on "Corrosion of knee-implants", Source: www.scopus.com

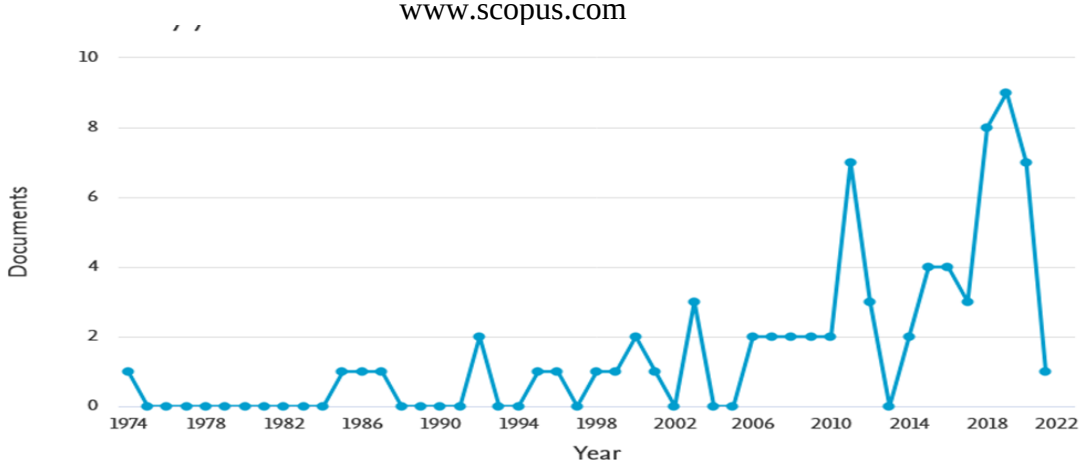

Figure 2: Period wise publication of articles, Source: WWW.scopus.com

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 22 authors, in eight 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.

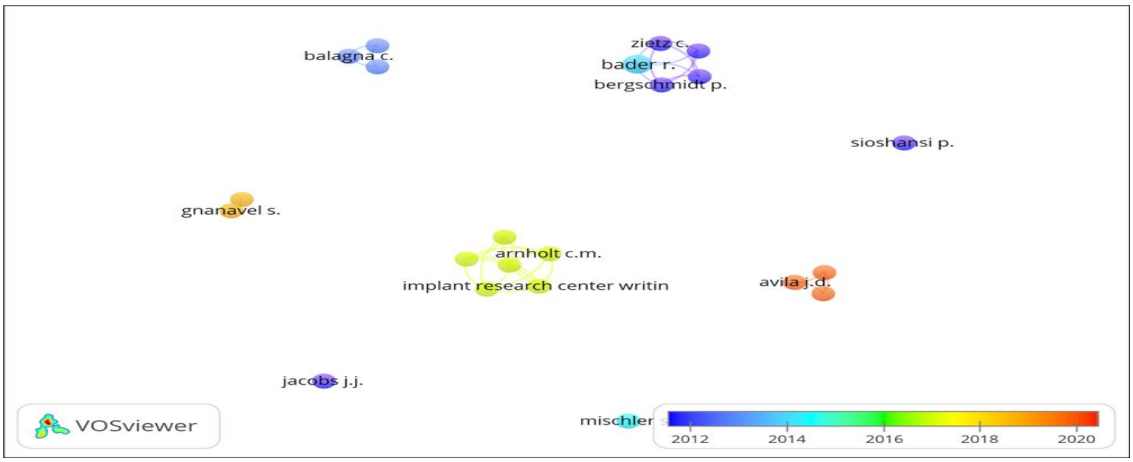

Figure 3: Co-authorship analysis on basis of authors

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 author on basis of publication	Bader R	3	11	3.7	16

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 21 thresholds, in three clusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Figure 4.

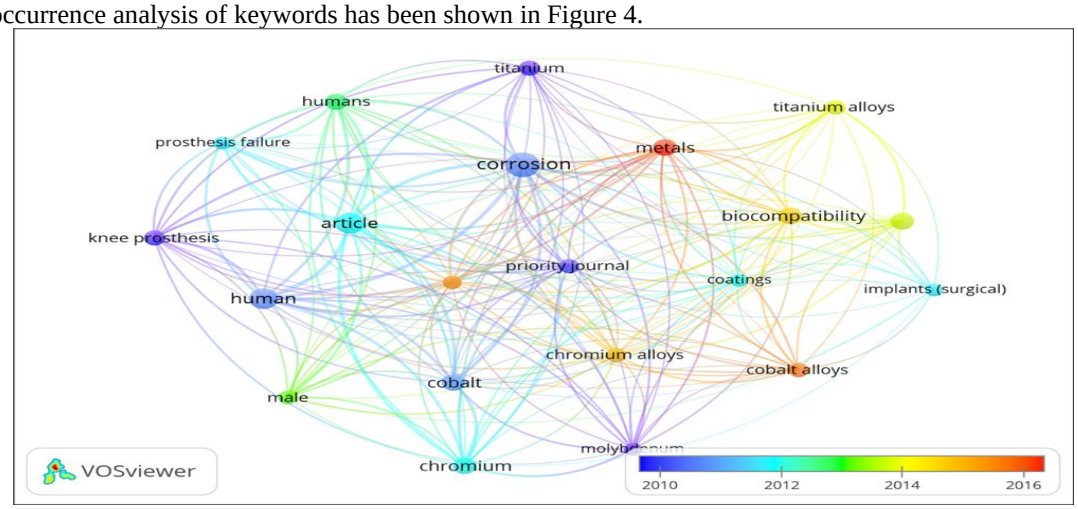

Figure 4: Co-occurrence analysis on basis of all keywords

The leading organizations engaged in research on “Corrosion of knee-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 knee-implants”, with the highest number of publications and citations, was the Drexel University and Rush University Medical Center of United States of America (Refer to table 2).

Table 2: Highlights of the most active organization

Organizations	Country	Documents	Citations	Average Citations per document
Drexel University	United States of America	3	26	9
Rush University Medical Center	United States of America	3	606	202

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

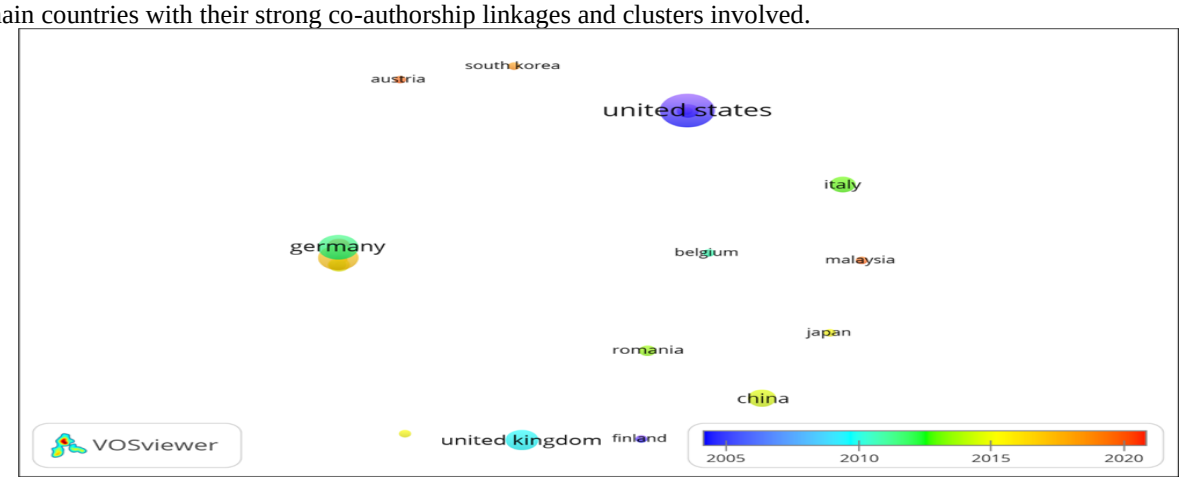

Figure 5: Co-authorship analysis on basis of countries

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	10	139	6
The country with the highest co-authorship links	India	19	1123	2

The most active country in this research domain was the United States of America and India with the highest number of publications and 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 knee-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	Co-authorship links
Leading journals on basis of publication	Wear	4	96	24	1
	Journal of Arthroplasty	4	79	20	1

From the above discussion regarding the bibliometric patterns in the research regarding corrosion of knee-implants, this research had observed a gradual increase in research interest regarding corrosion of knee-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 Bader R. with the highest publication, co-authorship links, and citations (Refer to table 1). The overlay analysis of top countries researching steel implants indicates that the United States of America and India were 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 Wear, and Journal of Arthroplasty. From these wide sources of information, researchers can focus on top journals where they can identify the most relevant and highly cited articles on corrosion of knee-implants.

4. Conclusion

Corrosion of knee-implants was an interesting research domain and the most active journals related to this research domain were the Wear, and Journal of Arthroplasty. The most active countries were the United States of America and India. The leading organizations engaged in the research regarding corrosion of knee-implants were the Drexel University and Rush University Medical Center of United States of America. The most active

author who had made valuable contributions related to knee implants Badar R with the highest publication, citations, and co-authorship links respectively. This research domain offers a new avenue for researchers and future research can be on innovations in knee-implants.

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