

A Detailed Review on Vanadium and Knee Implants

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Abstract

Vanadium is popularly used for knee implants. This review analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of “Vanadium knee-implants”. All published articles related to “Vanadium knee implants” from “Scopus”, were analyzed using the Meta Analysis to develop analysis tables and visualization maps. This article had set the objective to consolidate the scientific literature regarding “Vanadium knee-implants” and also to find out the trends related to the same. The leading Journals were the Biomaterials and Journal of Arthroplasty. The most active country was the United States of America. The leading organization engaged in the research regarding Vanadium knee implants was the Rush University Medical Center, USA. The most active authors who had made valuable contributions related to Vanadium knee implants were Hallab N.J and Murr L.E.

Keywords: Vanadium, knee-implants, Material engineering, Review analysis, Meta Analysis,

1. Introduction

Vanadium is used for diversified medical purposes including implants and other medical treatments. Vanadium implants range from orthopedic implants, knee implants, dental implants (Hadjimarkos, 1966; Galli *et al.*, 2011)(Zagury *et al.*, 2007)(Tank and Storvick, 1960; Tamura, 1976).The major issues associated with implants of Vanadium are the hypersensitivity and toxicity of the metal; development of systematic dermatitis and implant failure; Similarly poor functioning of implant and issues of cytotoxicity are also associated with Vanadium implants. The toxicity of Vanadium makes it less preferable for being used in the making of implants. Corrosion of Vanadium–implants is also an issue to be addressed. Various types of surface engineering and surface coating like thermal and chemical modifications can be conducted in Vanadium–implants to improve their performance and longevity(MacDonald *et al.*, 2004)(Cigada, Cabrini and Pedefferri, 1991). Vanadium can be used for biomaterials and researchers had found that vanadium doesn't have any adverse effect on red blood cells and can improve the anti-bacterial functions of the implant.

Vanadium is widely used for orthopedic implants including knee implants. Thin-film coating of Vanadium ensures abrasion resistance, resistance to corrosion, and many other positive mechanical properties. The sensitivity of Vanadium is very important for patients undergoing knee implants based on Vanadium (Granchi *et al.*, 2008).

Material engineering and surface engineering can play a significant role in improving the performance and life of Vanadium knee–implants along with measures for reducing toxicity and hypersensitivity of the metal. This review analysis will be a useful platform for future researchers by realizing the top researchers, organizations, and countries involved in research regarding Vanadium knee 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 review analysis systematically.

1.1 Research Objectives

- a) To consolidate the literature regarding Vanadium knee-implants
- b) To find out the trends related to research in Vanadium knee-implants

1.2 Research Questions

- a) Who are the active researchers working on Vanadium knee implants?
- b) Which are the main organizations and countries working on Vanadium knee implants?
- c) Which are the main journals on Vanadium knee implants?

2. Research Methodology

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE-ABS-KEY (Vanadium knee). All the tables in this paper were created by using Microsoft Excel and Meta Analysis. Grammarly was used for spelling and grammar checks. Mendeley was used for article review and citation. This paper had been inspired by review analysis in its presentation style, analysis, and methodology from the works.

3. Results and discussion

3.1 Results

This first round of search produced an outcome of 97 documents, in six languages, out of which 90 documents were in English. The classification of document categories is shown in Table 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 64 English articles (both open access and others) and had been used to conduct review analysis and visualization using Meta Analysis. The English research articles in this domain since 1974 had been shown in Table1. Co-authorship analysis of top authors had been shown in Table1. 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 12 authors, in five clusters. The overlay visualization map of co-authorship analysis plotted in Table1, points out the major researchers with their strong co-authorship linkages and clusters involved. 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	3	171	57	10
Authors with the highest citation	Murr . L.E	2	207	103.5	9

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 Table2. The leading organizations engaged in research on “Vanadium 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 “Vanadium knee-implants”, with the highest number of publications and citations, was the Rush University Medical Center(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	4	176	44

Co-authorship analysis of the countries engaged in the research on “Vanadium knee implants” had been shown in Table3. The overlay visualization map of co-authorship analysis plotted in Table3, points out the main countries with their strong co-authorship linkages and clusters involved.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	Average citation
The country with the highest publication, citations, and co-authorship links	United States of America	23	1105	5

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

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 “Vanadium knee-implants” are shown in table 4. Table 4shows 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	Links
Journal with the highest publications	Journal of Arthroplasty	4	91	22.5	2
Journal with highest co-authorship and citations	Biomaterials	3	302	101	4

From the above discussion regarding the review patterns in the research regarding Vanadium knee implants, this research had observed a gradual increase in research interest regarding Vanadium 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 Table 2).The most active authors in this research domain were Hallab N.J and Murr L.E with the

highest publication, co-authorship links; and citations respectively (Refer to table 1). The overlay analysis of top countries researching Vanadium knee 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 Table 5). The top journals of this research domain were identified as the Biomaterials 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 regarding Vanadium knee implants.

4. Conclusion

Vanadium dental implants was an interesting research domain and the most active journals related to this research domain were the Biomaterials and Journal of Arthroplasty. The most active country was the United States of America. The leading organization engaged in the research regarding Vanadium knee implants was the Rush University Medical Center, USA. The most active authors who had made valuable contributions related to Vanadium knee implants were Hallab N.J and Murr L.E. This research domain offers a new avenue for researchers and future research can be on innovations in Vanadium knee implants.

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