Investigations on Surface Coating of Cobalt based Implants

Asheesh Kumar Gupta, Professor, Department of Basic Sciences, Galgotias University

Abstract

Cobalt is one of the most used metals for implants. The review analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of "Surface coating of Cobalt-implants". All published articles related to "Surface coating of Cobalt-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 "Surface coating of Cobalt-implants" and also to find out the trends related to the same.The most active journals in this research domain were the Clinical Orthopaedics and Related Research and Journal of Bone and Joint Surgery. The most active country was the United States of America. The leading organization engaged in the research regarding Surface coating of Cobalt-implant was the Rush University Medical Center, USA. The most active authors who had made valuable contributions related to Cobalt implants were Hart A.J and Joseph J. J.

Keywords: Cobalt-implants, Surface coating, Material engineering, Review analysis, Meta Analysis

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 various types of implants had been used in modern medicine. Cobalt is widely used for diversified dental implants (Peterson, McKinney and Pennel, 1978)(Harris and Lossin, 1971); Cobalt and Cobalt alloys are one of the widely used biomaterials, especially for hip implants; hip and knee replacements (Aminatun *et al.*, 2014); The cobalt-based implants are stronger and have better mechanical properties and performance, biocompatibility and wear resistance can be enhanced by a surface coating of Cobalt implants (Spriano *et al.*, 2005).

Fabrication techniques can be used for enhancing the applicability of Cobalt-based dental implants by developing dental implants having a porous coating (Klawitter, Weinstein and Peterson, 1977). The carcinogenic potential of Cobalt-based implants is an important issue to be addressed and this problem can be handled by sol-gel hybrid coatings in cobalt-based implants. The coating is conducted using methyltriethoxysilane (MTES) and tetraethylorthosilicate (TEOS) acidic sol. The dip-coating method is applied onto ASTM F75 alloys sintered at 450 °C and 550 °C.(Amato *et al.*, 2005).The sintering temperature is very crucial to enhance the quality of hydroxyapatite surface coating on Cobalt implants (Minouei *et al.*, 2012).

Material engineering and surface engineering can play a significant role in enhancing the performance of cobalt-based implants. Future research can be on research niches surface modification to Cobalt-based implants, for reducing the toxicity of Cobalt-based implants. Issues connected with corrosion and failure of Cobalt-based implants are also equally important.This review 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 review analysis systematically.

1.1 Research Objectives

a) To consolidate the literature regarding Surface coating of Cobalt-implants
b) To find out the trends related to research in the Surface coating of Cobalt-implants

1.2 Research Questions

a) Who are the active researchers working on the Surface coating of Cobalt-implants?
b) Which are the main organizations and countries working on the Surface coating of Cobalt-implants?
c) Which are the main journals Surface coating of Cobalt-implants?

2. Research Methodology

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE(Surface Cobalt-implants). 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 767 documents, in10 languages, out of which 735 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 581English 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 1962 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 five and the minimum number of citations of authors as one. This combination plotted the map of 25 authors, in 13clusters. 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 citations	Jacobs J.J.	13	1921	147.7	55
Authors with the highest Co-authorship links	Hart A.J	8	155	19.5	56

In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrences of a keyword as60. This combination plotted the map of 35thresholds, in two clusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Table2.The leading organizations engaged in research on "Surface coating 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 "Surface coating 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	17	2460	144.6

Co-authorship analysis of the countries engaged in the research on "Surface coating of Cobalt-implants" had been shown in Table2. The overlay visualization map of co-authorship analysis plotted in Table2, 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	Link strength
The country with the highest publication, citations, and co-authorship links	United States of America	200	8628	52

The most active country in this research domain was the United States of America, with the highest number of publications, co-authorship links, 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 "Surface coating of Cobalt-implants" are shown in table . 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
Journal with the highest publications	Clinical Orthopaedics and Related Research	23	1820	36
Journal with highestcitations and co-authorship	Journal of Bone and Joint Surgery	14	2445	50

From the above discussion regarding the review patterns in the research regarding the Surface coating of Cobalt-implant, this research had observed a gradual increase in research interest regarding Surface coating of Cobalt-implantfrom 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 Hart A.J and Jabob J. J with the highest publication and co-authorship links; and citations respectively(Refer to table 1).The overlay analysis of top countries researching Surface coating of Cobalt-implant indicates that the United States of America was the leading country relating tothe highest number of publications, citations, and co-authorship links(Refer to Table 5). The top journals of this research domain were identified as the Clinical Orthopaedics and Related Research 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 Surface coating of Cobalt-implant.

4. Conclusion

Surface coating of Cobalt-implant was an interesting research domain and the most active journals related to this research domain were the Clinical Orthopaedics and Related Research and Journal of Bone and Joint Surgery. The most active country was the United States of America. The leading organization engaged in the research regarding Surface coating of Cobalt-implant was the Rush University Medical Center, USA. The most active authors who had made valuable contributions related to Cobalt implants were Hart A.J andJoseph J. J with the highest publication and co-authorship links; and citations respectively. This research domain offers a new avenue for researchers and future research can be on innovations in the Surface coating of Cobalt-implant.

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