

# A Review on Tantalum-Implants

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## Abstract

Tantalum 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 “Tantalum-implants”. All published articles related to “Tantalum-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 “Tantalum-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 Tantalum-implants was the Mayo Clinic, USA. The most active authors who had made valuable contributions related to Tantalum-implants were Lewallen. G, Bungler C. and Tanzer M.

**Keywords:** Tantalum-implants, 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. Tantalum had been used for diversified purposes. Tantalum had been used for various orthopaedic implants, like wrist arthrodesis (Adams *et al.*, 2005); for structural allo-grafting (Antoniou, Walsh and Nikolaou, 2011). Corrosion and antibacterial infection of implants is a major threat for bio implants and surface coating (Szabó, Kovács and Vargha, 1995); can be a good remedy for the issue of anti-bacterial infection and corrosion of implants. Similarly, the high concentration of metals in body fluids, toxicity and allergy of metals should also be considered in the cases of bio implants. However there are evidences for that Free radicals generated by tantalum implants antagonize the cytotoxic effect of doxorubicin (Chen *et al.*, 2013).

Similarly its safer to use Tantalum in achieving anterior cervical fusion following 1-level discectomy as treatment of degenerative cervical disc disease with radiculopathy (Fernández-Fairen *et al.*, 2008). The a electro-migration lifetime of Copper wires, can be improved by using Tantalum implantation into Copper implants (Gambino *et al.*, 2007). Recent studies had found that the porous Tantalum rod can be effective for early-stage osteonecrosis of the femoral head patients in short period of time. Tantalum implants were also used for disc replacement (Matějka, Zeman and Belatka, 2009). Tantalum has been used as markers for evaluating postoperative orthognathic surgical changes (Rubenstein *et al.*, 1993).

Material engineering and surface engineering can play a significant role in improving the performance and life of Tantalum-implants along with measures for reducing toxicity and hypersensitivity of the metal implants. Future research can also be on surface coatings by using, metal implants using Tantalum. This review analysis will be a useful platform for future researchers by realizing the top researchers, organizations, and countries involved in research regarding Tantalum-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 Tantalum-implants
- b) To find out the trends related to research in Tantalum-implants

## 1.2 Research Questions

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

## 2. Research Methodology

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE-ABS (Tantalum-implant). 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 844 documents, in 12 languages, out of which 772 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 630 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 1943 had been shown in Table 1. Co-authorship analysis of top authors had been shown in Table 1. For a better presentation of the analysis, the parameters used were the minimum number of documents of an author as six and the minimum number of citations of authors as one. This combination plotted the map of 24 authors, in 12 clusters. The overlay visualization map of co-authorship analysis plotted in Table 1, 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         | Lewallen. G | 15        | 723       |                                 | 62            |
| Authors with the highest co-authorship links | Bunger C.   | 11        | 283       |                                 | 73            |
| Authors with the highest citations           | Tanzer M    | 6         | 1510      |                                 | 25            |

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 32 thresholds, in two clusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Table 2. The leading organizations engaged in research on “Tantalum-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 “Tantalum-implants”, with the highest number of publications and citations, was the Mayo Clinic (Refer to table 2).

Table 2: Highlights of the most active organization

| Organizations | Country                  | Documents | Citations | Average Citations per document |
|---------------|--------------------------|-----------|-----------|--------------------------------|
| Mayo Clinic   | United States of America | 19        | 665       | 35                             |

Co-authorship analysis of the countries engaged in the research on “Tantalum-implants” had been shown in Table 3. The overlay visualization map of co-authorship analysis plotted in Table 3, 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 | 193       | 5931      | 57            |

The most active country in this research domain was the United States of America, with the highest number of publications, 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 “Tantalum -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 | Links |
|---|-------------------------|-----------|-----------|---------------------------------|-------|
| Journal with the highest publications and co-authorship links | Journal of Arthroplasty | 33        | 1303      | 39.4                            | 226   |
| Journal with highest citations                                | Biomaterials            | 7         | 1516      | 216.5                           | 91    |

From the above discussion regarding the review patterns in the research regarding Tantalum-implants, this research had observed a gradual increase in research interest regarding Tantalum-implants from the starting of the millennium, and the momentum are 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 Lewallen. G, Bungler C. and Tanzer MJ. J with the highest publication, co-authorship links, and citations respectively (Refer to table 1). The overlay analysis of top countries researching Tantalum-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 Tantalum-implants.

#### 4. Conclusion

Tantalum-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 Tantalum-implants was the Mayo Clinic, USA. The most active authors who had made valuable contributions related to Tantalum-implants were Lewallen. G, Bungler C. and Tanzer M. This research domain offers a new avenue for researchers and future research can be on innovations in Tantalum-implants.

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