A Review on Aluminium Based Ortho Implants

S. Kennedy, Associate Professor, Department of Mechanical & Chemical Engineering, Galgotias University

Abstract

This research paper is the visualisation of research trends in Aluminium-based orthopaedic implants through Review analysis. This research will help to understand the active authors, organizations, journals, and countries involved in the research of "Aluminium ortho-implants". All published articles related to "Aluminium orthopaedic-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 "Aluminium orthopaedic-implants" and also to find out the trends related to the same. The leading Journals were the Journal of Orthopedic Research and Biomaterials. The most active country was the United States of America. The leading organization engaged in the research regarding Aluminium orthopedic-implants was the Rush University Medical centre. The most active authors who had made valuable contributions related to Aluminium ortho-implants were Boyd.D and Jacobs J.J.

Keywords: Aluminium, Orthopedic-implants, Material engineering, Review analysis, Meta Analysis.

1. Introduction

Aluminium based orthopaedic implants are a popular type of implants. Aluminium implants are widely used for bone implants, knee and hip implants The major challenge associated with Aluminium-based orthopaedic implants is corrosion of the Aluminium implants.(Bayer, Tiwari and Megaridis, 2008). However, the threat of corrosion of Aluminium implants can be handled by the advances in material engineering; surface coating; and by using Aluminium free implants. The other challenges faced by the Aluminium ortho implants are the allergy or hypersensitivity; and toxicity of Aluminium implants. However, the toxicity and allergy of Aluminium implants are comparatively negligible and thus much safer than several counterparts. Another issue associated with Aluminium implants is the high level of serum Aluminium level (Grübl *et al.*, 2006) and lead to various complicated health issues. But contradictory studies are highlighting that there is no evidence for high-level Aluminium content (Adams *et al.*, 2003) Issues of cracks were also associated with Aluminium-based implants (Kubota *et al.*, 1998).

Aluminium based materials were used for various types of tissue repairs and tissue replacements (Alexander *et al.*, 1985). Similarly, Aluminium sheets were used for heat support for orthopaedic applications. Aluminium foils were widely applied for tissue engineering (Bayer, Tiwari and Megaridis, 2008). Various types of orthopaedic treatments can be conducted the Aluminium and Aluminium-based alloys.

Material engineering and surface engineering can play a significant role in improving the performance and life of Aluminium ortho–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 Aluminium ortho-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 Aluminium orthopedic-implants
b) To find out the trends related to research in Aluminium orthopedic-implants

1.2 Research Questions

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

2. Research Methodology

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE-ABS (Aluminium orthopaedic). 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 270 documents, in10 languages, out of which 246 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 of181English 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 1971 had been shown in Figure1.

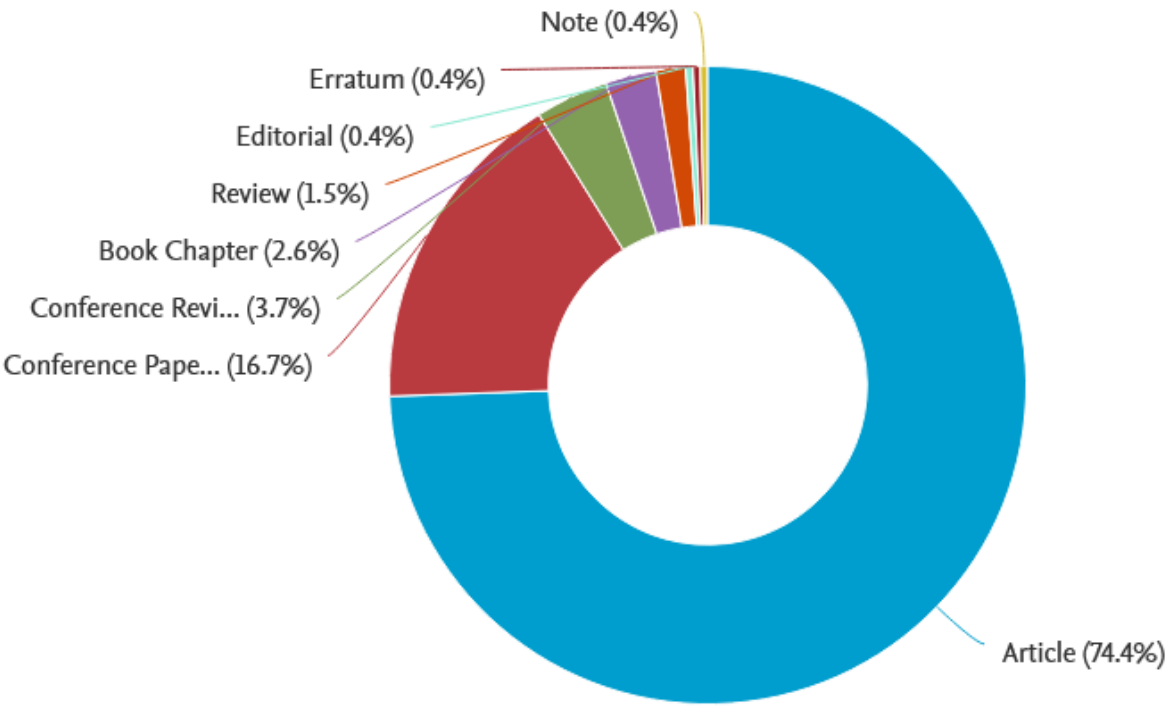

Figure1: Classification of the documents on “Aluminium ortho -implants”

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 three and the minimum number of citations of authors as one. This combination plotted the map of10authors, in 4clusters. 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.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	Boyd D.	6	211	35	18
Authors with the highest citations	Jacobs J.J.	5	1209	242	18

In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrences of a keyword as 20. This combination plotted the map of 22 thresholds, in two clusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Table2.The leading organizations engaged in research on "Aluminium orthopaedic-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(Singh and Kumar, 2013). The leading organization in the research regarding "Aluminium orthopaedic-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	6	1232	205

Co-authorship analysis of the countries engaged in the research on "Aluminium orthopaedic-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 acountry 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 leading publication, citations, and co-authorship links	United States of America	65	3321	18

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 "Aluminium orthopedic-implants" are shown in table 4. Table 4shows the journal activity of this research domain through parameters of publication volume and citations.

Table 4: Analysis of journal activity

Description	Journal details	Documents	Citations	Average citations per documents
Journal with the highest publications	Journal of Orthopedic Research	17	1052	62
Journal with the highest citations	Biomaterials	8	1059	132.5

From the above discussion regarding the Review patterns in the research regarding Aluminium orthopedic-implants, this research had observed a gradual increase in research interest regarding Aluminium orthopedic-implantsfrom 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 Boyd D. and Jacobs J.J with the highest publication and citations respectively(Refer to table 1).The overlay analysis of top countries researching Aluminium orthopaedic-implants indicates that the United States of America was the leading country relating to the highest number of publications and citations (Refer to Table 5). The top journals of this research domain were identified as the Journal of Orthopedic Research and Biomaterials. From these wide sources of information, researchers can focus on top journals where they can identify the most relevant and highly cited articles regarding Aluminium ortho–implants.

4. Conclusion

Aluminium ortho-implants was an interesting research domain and the most active journals related to this research domain was the Journal of Orthopedic Research and Biomaterials. The most active country was the United States of America. The leading organization engaged in the research regarding Aluminium orthopedic-implants was the Rush University Medical center. The most active authors who had made valuable contributions related to Aluminium ortho-implants were Boyd. D and Jacobs J.J. This research domain offers a new avenue for researchers and future research can be on innovations in Aluminium ortho-implants.

References

1. Adams, J. E. *et al.* (2003) 'Prosthetic implant associated sarcomas: A case report emphasizing surface evaluation and spectroscopic trace metal analysis', *Annals of Diagnostic Pathology*, 7(1), pp. 35–46. doi: 10.1053/adpa.2003.50006.
2. Alexander, H. *et al.* (1985) 'ABSORBABLE COMPOSITES AS ORTHOPEDIC IMPLANTS.', in *Transactions of the Annual Meeting of the Society for Biomaterials in conjunction with the Interna*. San Diego, CA, USA: Soc for Biomaterials, San Antonio, TX, USA, p. 215.
3. Bayer, I. S., Tiwari, M. K. and Megaridis, C. M. (2008) 'Biocompatible poly(vinylidene fluoride)/cyanoacrylate composite coatings with tunable hydrophobicity and bonding strength', *Applied Physics Letters*, 93(17). doi: 10.1063/1.3009292.
4. Farhat, T. *et al.* (2013) 'Research in congenital heart disease: A comparative Review analysis between developing and developed countries', *Pediatric Cardiology*, 34(2), pp. 375–382. doi: 10.1007/s00246-012-0466-6.
5. Grübl, A. *et al.* (2006) 'Serum aluminium and cobalt levels after ceramic-on-ceramic and metal-on-metal total hip replacement', *Journal of Bone and Joint Surgery - Series B*, 88(8), pp. 1003–1005. doi: 10.1302/0301-620X.88B8.17870.
6. Kubota, M. *et al.* (1998) 'Crack propagation properties on hip-treated cast aluminum alloys', *Materials Science Research International*, 4(3), pp. 193–199.
7. Singh, H. and Kumar, R. (2013) 'Measuring the utilization index of advanced manufacturing technologies: A case study', in *IFAC Proceedings Volumes (IFAC-PapersOnline)*. Saint Petersburg: IFAC Secretariat, pp. 899–904. doi: 10.3182/20130619-3-RU-3018.00395.
8. Subramanian, B., Ananthakumar, R. and Jayachandran, M. (2010) 'Microstructural, mechanical and electrochemical corrosion properties of sputtered titanium-aluminum-nitride films for bio-implants', *Vacuum*, 85(5), pp. 601–609. doi: 10.1016/j.vacuum.2010.08.019.