Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 1, 2021, Pages. 3486 - 3494

Received 15 December 2020; Accepted 05 January 2021.

A Bibliometric Analysis and Visualisation of Research Trends in Bio-Implants

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Abstract

Nanotechnology had been a breakthrough in material engineering and it opened Nanotechnology into the pharmaceutical and medical sectors. Thebibliometric analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of "Bio-implants".All published articles related to "Bio-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 "Bio-implants"and also to find out the trends related to the same.The most active journal in this research domain wasClinical Oral Implants research. The most active country was India. The leading organizations engaged in the research regarding Bio-implants was the Indian Institute of Technology Kharagpur of India. The most active authors who had made valuable contributions related to pacemaker batteries were Subramanian B, Lindhe. J and Shokuhfar. T with the highest publication, citation, and co-authorship links respectively

Keywords: Bio-implants,Material engineering,Bibliometric analysis, VOS viewer,

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 Titanium[1]. Innovations and advances in material engineering and surface engineering play a key role in developing modern implants[2]. Cost, acceptability of implant by the body and surrounding cells, lifetime of implants, post-implantation monitoring, and post-implantation failures are to be considered before implantation. The other factors to be considered for successful implantations are chemical stability, mechanical behavior, and corrosion of the implants. Corrosion of bio-implants due to body fluids is an important issue addressed in all bio implantations [3]. The major remedial measures against corrosion of implants are to bulk alloy stainless steel with Titanium and Nitrogen; bioceramic coatingetc[4] Laser treatment can also be considered for dealing with corrosion of implants. Surface melting by laser treatment would reduce the corrosion potential of bio-implants [5][6][7][8][9] similarly the performance of bio-implants can be improved by using ultrafast laser-induced self-assembled Nano texture in titanium [10]; Boride coating on the Ti-6Al-4V alloy against corrosion of bio-implants [11]. Bio implant performance is heavily dependent

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upon cell behavior and by surface topography, the performance of bio-implants can be improved [12][13]; calcium coating of bio-implants [14]; using integrated anodization and thermal oxidation for improving bio implants [15] using Friction Stir Processing (FSP) for developing corrosion resistant surfaces [16].

Engineered biomaterials placed inside the human body are called implants and various types of implants had been used in modern medicine[17], [18] and include sensory implants, neurological implants, cardiovascular implants, orthopedic implants, contraceptive implants, and cosmetic implants. Some latest developments related to implants include bioactive glass/ bioglass coating, surface texturing, and additive manufacturing to improve the quality, life, and performance of implants [19].

The promising research niches related to material engineering[20], [21] and bio-implants are the development of new materials for implants, new technology against corrosion, and the development of wireless and automated 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 bio-implants
b) To find out the trends related to research in Bio-implants

1.2 Research Questions

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

RESEARCH METHODOLOGY

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE (bio-implants)on 18/01/2021. 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 [22]–[28].

RESULTS AND DISCUSSION

a. Results

This first round of search produced an outcome of319 documents, insevenlanguages, out of which 291 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 186 English articles (both open

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access and others) andhad been used to conduct bibliometric analysis and visualization using VOS Viewer. The English research articles in this domain since 2006 had been shown in Figure 2.

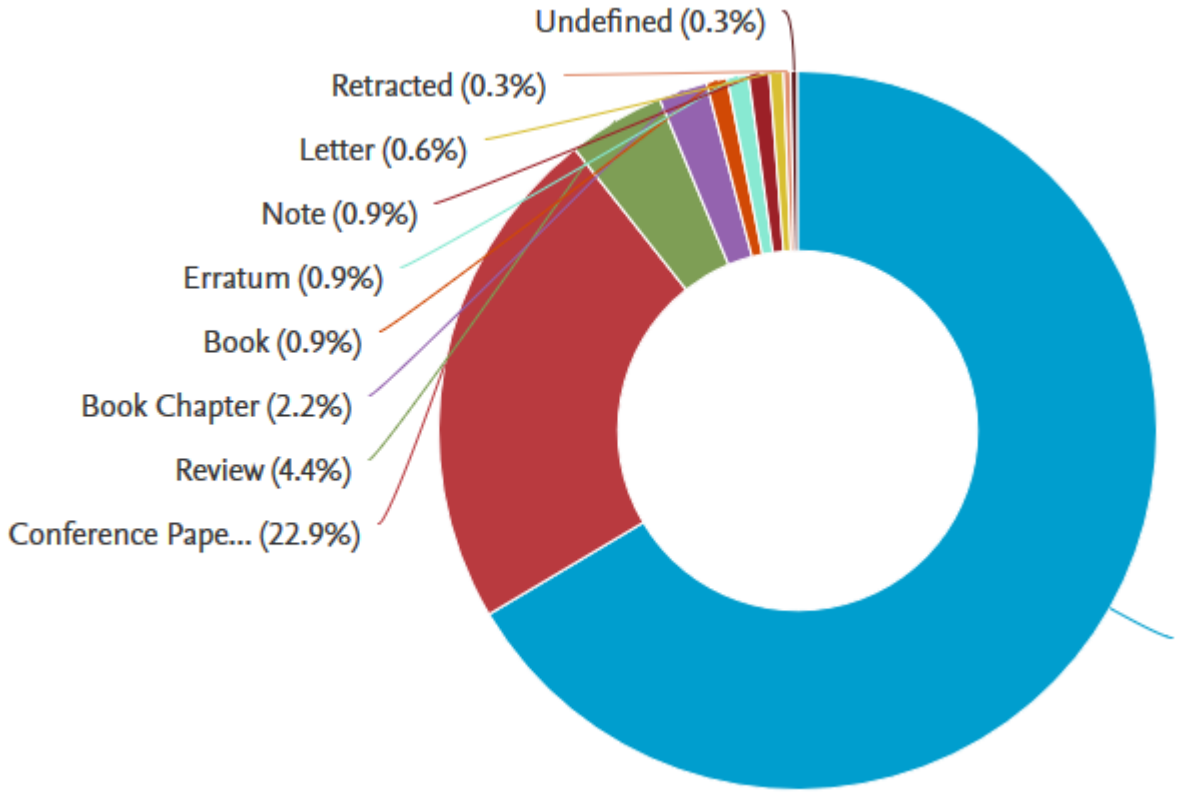

Figure 1: Classification of the documents on "Bio-implants", Source: www.scopus.com

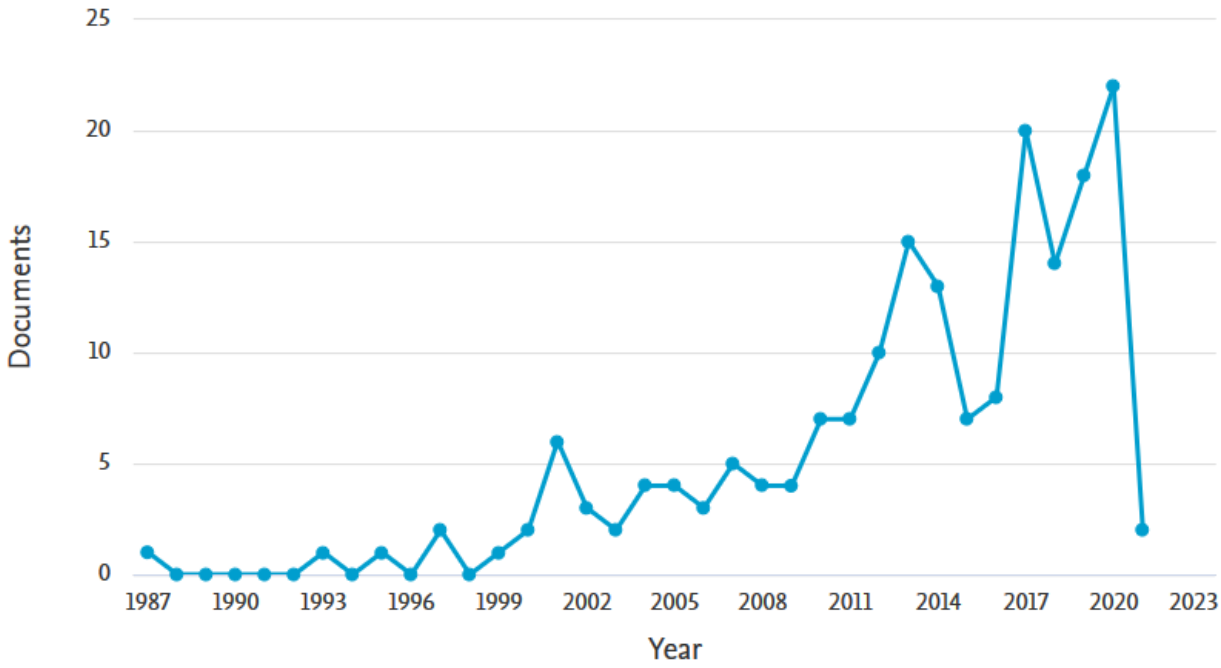

Figure 2: Period wise publication of articles, Source: WWW.scopus.com

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

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threeand the minimum number of citations of authors as one. This combination plotted the map of12 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.

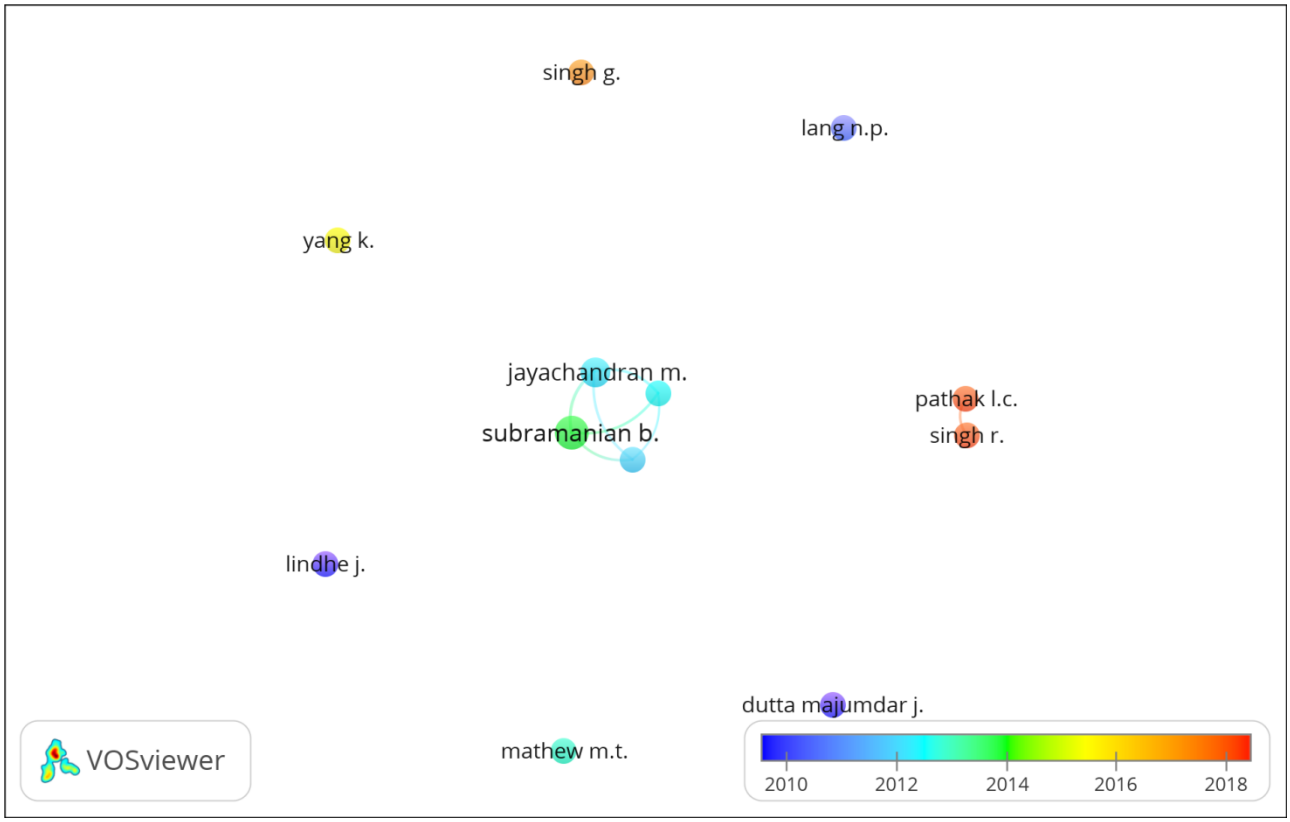

Figure 3: Co-authorship analysis on basis of authors

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
Authors with the highest publication	Subramanian B	5	194	28.8	15
Authors with the highest citations	Lindhe. J	3	597	199	7
Authors with the highest co-authorship links	Shokuhfar. T	2	42	21	25

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In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrences of a keyword as20. This combination plotted the map of 24thresholds, in three clusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Figure 4.

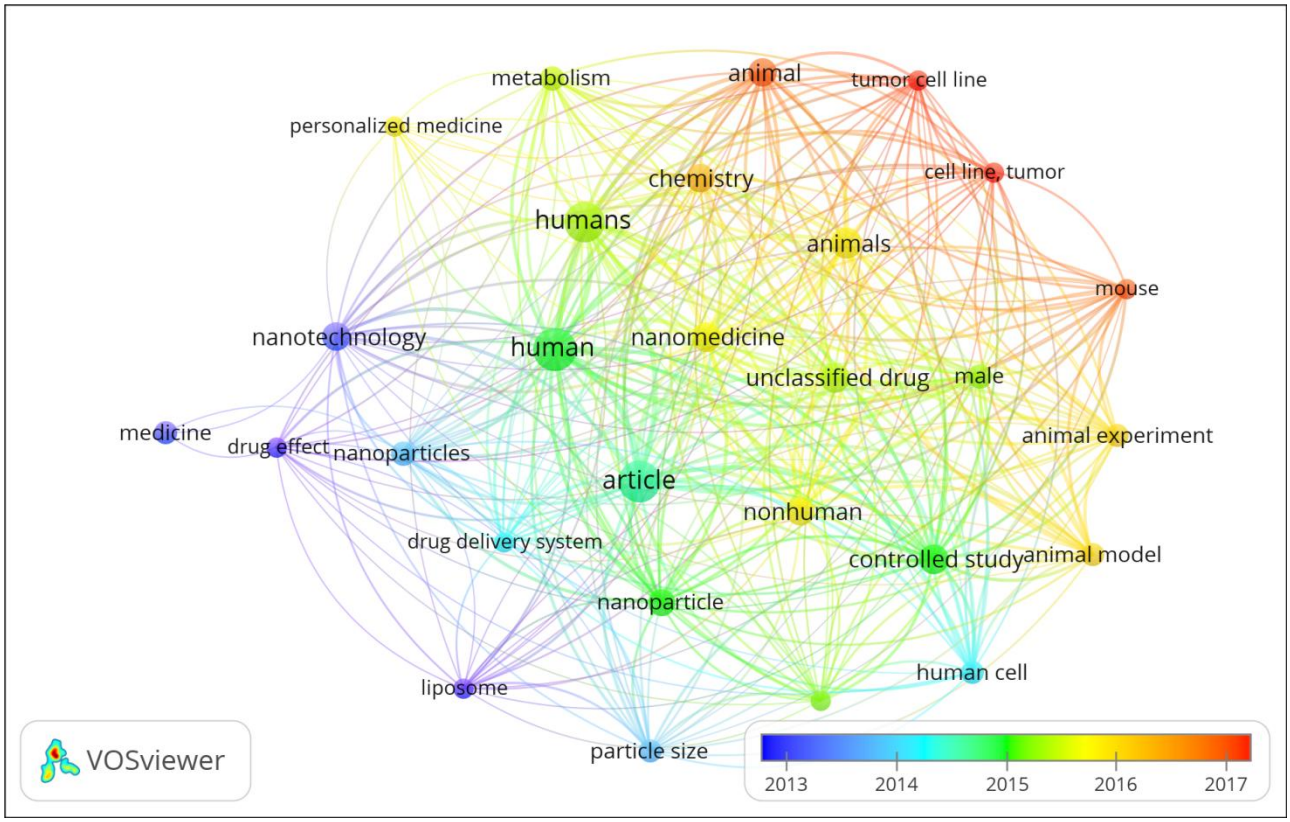

Figure 4: Co-occurrence analysis on basis of all keywords

The leading organizations engaged in research on “Bio-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 “Bio-implants”, with the highest number of publications and citations,was the Indian Institute of Technology Kharagpur, India. (Refer to table 2).

Table 2: Highlights of the most active organization

Organizations	Country	Documents	Citations	Average Citations per document
Indian Institute of Technology Kharagpur	India	6	52	8.6

Co-authorship analysis of the countries engaged in the research on “Bio-implants” had been shown in Figure 5. The overlay visualization map of co-authorship analysis plotted in Figure

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5, points out the main countries with their strong co-authorship linkages and clusters involved.

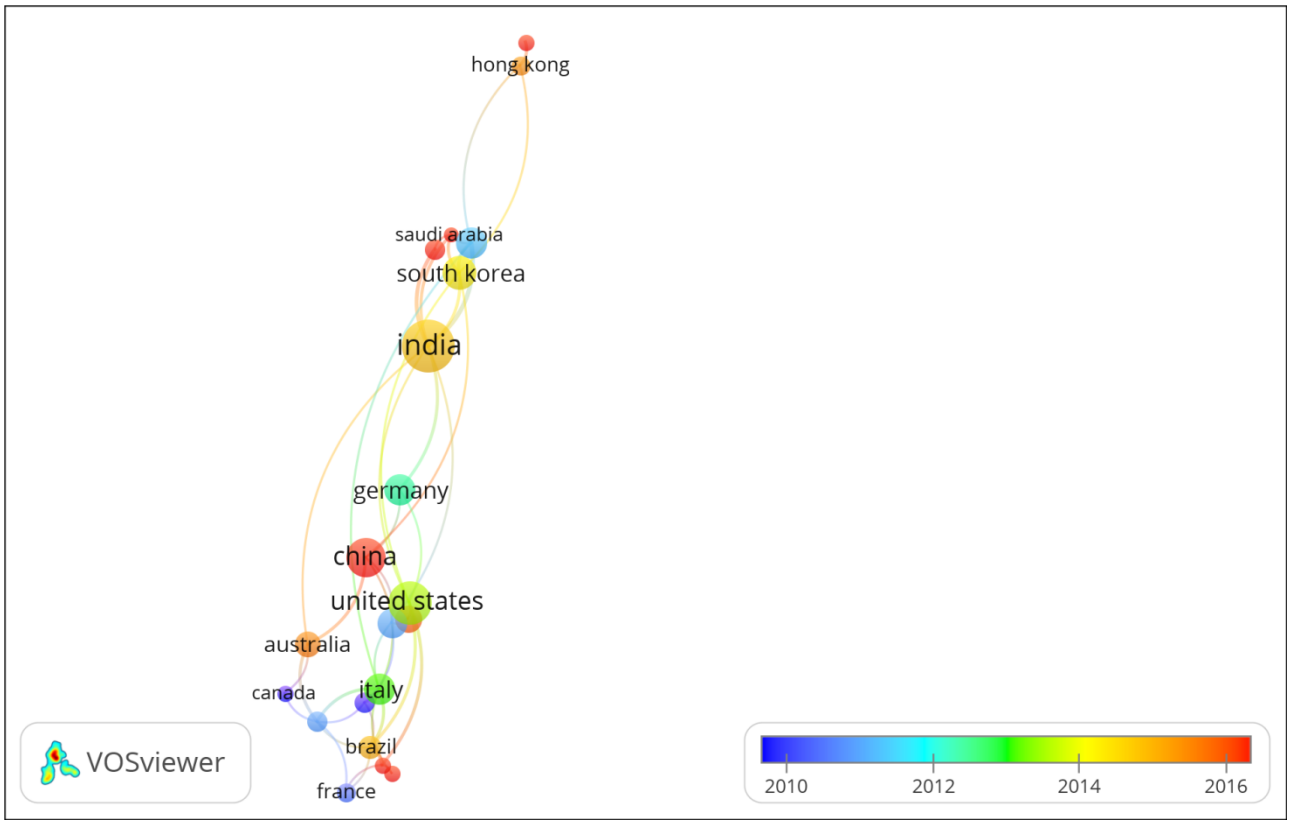

Figure 5: Co-authorship analysis on basis of countries

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 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 highest publication, citations, and co-authorship links	India	37	775	22

The most active country in this research domain was India, with the highest number ofpublications, 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 “Bio-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
Journal with the highest publications, and co-authorship links	Clinical Oral Implants research	9	727	80.9

From the above discussion regarding the bibliometric patterns in the research regarding Bio-implants,this research had observed a gradual increase in research interest regarding Bio-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 Figure 2).The most active authors in this research domainwere Subramanian B, Lindhe. J and Shokuhfar. T with the highest publication, citation, and co-authorship links respectively(Refer to table 1).The overlay analysis of top countries researching pacemaker batteriesindicates that India was the leading countryrelating tothe highest numberof publications, citations, and co-authorship links(Refer to figure 5). The top journal of this research domain was identified as the International Journal of Bio-implants.Fromthese wide sources of information, researchers can focus on top journals where they can identify the most relevant and highly cited articles regarding Bio-implants.

CONCLUSION

Bio-implantswas an interesting research domain and the most active journal related to this research domain was the Clinical Oral Implants research.The most active countrywas India.The leading organizations engaged in the research regarding Bio-implants was the Indian Institute of Technology Kharagpur of India. The most active authors who had made valuable contributions related topacemaker batterieswere Subramanian B, Lindhe. J and Shokuhfar. T with the highest publication, citation, and co-authorship links respectively.This research domain offers a new avenue for researchers and future research can be on innovations in Bio-implants.

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