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Bioengineering of Dental Tissues: Bibliometric Analysis 2000-2011.

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Abstract: Introduction: There has been a noticeable increase in experimental use and therapies based on stem cells over recent years. Nevertheless, there is a lack of information about this progress in the dental field, which makes it difficult to trace development and design policies. The purpose of this study, as a first approach to the subject, is to determine a bibliometric profile for the investigation related to bioengineering of dental tissue at a worldwide scale, based on the MEDLINE database, for the period 2000-2011. Methodology: A bibliometric study was carried out. Every article indexed in the MEDLINE database and associated with the terms "stem cells" and "tooth regeneration" for the period 2000-2011 was included. The analyzed variables were publishing date, country of origin, language and publication type (original or review), journal, author, associated university and tissue source (human or animal). Results: For the entire period included in the study, 257 articles were found. Of these, 149 corresponded to original works published in English; 5 in other languages; 92 comprised literature reviews in English, 9 in other languages and 2 publications were included in the "others" category. The countries with the highest research productivity were the United States (24.51%), Japan (20.62%) and China (17.90%), while Brazil (3.9%) was the only Latin-American country found in the list. Animal tissues were used in 59.09% of them. The most productive authors were Ueda M (17) and Jin Y (11), whereas Fourth Military University (13), University of Tokyo (12) and Capital Medical University (10) had the largest number of publications. Conclusion: The United States, Japan and China concentrate about two thirds of the production. Latin-America was represented only by Brazil.

Keywords: Stem Cells [MeSH], Tooth regeneration, Bibliometrics [MeSH].

Bioingeniería de tejidos dentales: Análisis bibliométrico 2000-2011.

Resumen: Introducción: El creciente uso experimental de células madres y el perfeccionamiento de las terapias con estas es un hecho notorio en los últimos años. Sin embargo, en odontología no existen datos del desarrollo de esta área, lo que hace difícil un seguimiento o diseño de políticas. El objetivo de este estudio, siendo una primera aproximación a la temática, es definir el perfil bibliométrico de la investigación asociada a la bioingeniería de tejidos dentales a nivel mundial en la base de datos MEDLINE para el periodo 2000-2011. Metodología: Estudio bibliométrico. Se incluyeron todos los artículos asociados a los términos "stem cells" y "tooth regeneration" para el periodo 2000-2011, indexadas en MEDLINE. Se analizaron las variables: año de publicación, país de origen, idioma y tipo de publicación (original o revisión), revista, autor, universidad de afiliación y origen del tejido utilizado (humano o animal). Resultados: Para todo el período en estudio se hallaron 257 artículos: 149 trabajos de originales publicados en inglés, 5 en otros idiomas; 92 revisiones de literatura en inglés y 9 en otros idiomas; y 2 publicaciones en categoría otros. Los países más productivos fueron Estados Unidos (24,51%), Japón (20,62%), China (17,90%), el único latinoamericano es Brasil (3,9%). El 59,09% utilizó tejidos de origen animal. Los autores más productivos fueron Ueda M (17) y Jin Y (11), en universidades fueron Fourth Military University (13), University of Tokyo (12) y Capital Medical University (10). Conclusión: Estados Unidos, Japón y China concentran dos tercios de la producción, Brasil es el único representante latinoamericano.

Palabras clave: Células madre, regeneración dental, bibliometría.

Introduction.

Bioengineering is a transversal science associated with stem cell use since its early days. However, it will be understood as the *"strategic use of biological resources"*¹

Promoting policies apropos of research and development (R&D) is fundamental for focusing efforts on the growth of a competitive industry with the potential to generate innovation and new technologies². For example, India and several other countries have encouraged R&D strategies and started to quantify and assess their centers³, evaluate co-authorship systems⁴

and international cooperation between universities and private entities for investing their resources advantageously. Another important challenge faced by India and Brazil, for instance, was to revise their internal policies concerning state funding and universities for improving their investigation capabilities in the medium and long term^{5, 6}.

The importance of bibliometric studies lies in reading patterns of understanding between what is happening in neighboring countries or continents and the public policies (and private interventions) adopted by each one^{7, 8}. This can be observed clearly in the

robotics development policies and their mappings in Asian countries⁹.

In the field of dental sciences, there is not much bibliometric research for quantifying and orienting new knowledge generation¹⁰. Bioengineering of dental tissue has grown in the last few years in Chile, without any ISI publications, though¹¹. Given the importance of bibliometric information to enhance research policies, this study aims to analyze publications related to bioengineering of dental tissues worldwide for the period 2000-2011. This study included identifying authorships, types of studies and used tissues. Yet, it is necessary to highlight this investigation constitutes a first approach to the subject with numerous interpretative limitations since there are no references for establishing cause-effect relations between the variables.

Materials and methods.

A bibliometric study was conducted in the area of dental tissue bioengineering, specifically on tooth regeneration and stem cell use. The included publications were those indexed in the MEDLINE database for the period 2000-2011.

For determining publications, the terms “tooth regeneration” and “stem cell” were simultaneously entered in an advanced search engine. The analyzed variables were publishing year, country of origin, language and type of publication (original or review), author, associated university, tissue source and journal. Duplications were eliminated.

The filters used for classification were type of article, date and kind of publication from the MEDLINE database. Two researchers (SZ and LG) created and verified the classification sorting by author, affiliated university, type of tissue and country of origin according to data from the platform. They were previously calibrated and obtained a Kappa correlation over 0.8.

Data tabulation and display were done with MS Excel 2003. Then, an exploratory data analysis was made using descriptive statistics.

Results.

For the entire period, a total of 257 articles were found. From the total, 149 were original papers published in English, 5 were in other language. There were 92 literature reviews in English and 9 in other languages. Finally, 2 publications were included in the “others” category. Distribution for article publications per year is shown in Figure 1.

The six most productive countries were the United States (24.51%), Japan (20.62%), China (17.90%), the United Kingdom (4.67%), South Korea (4.28%) and Brazil (3.89%). This distribution can be appreciated in

Figure 2.

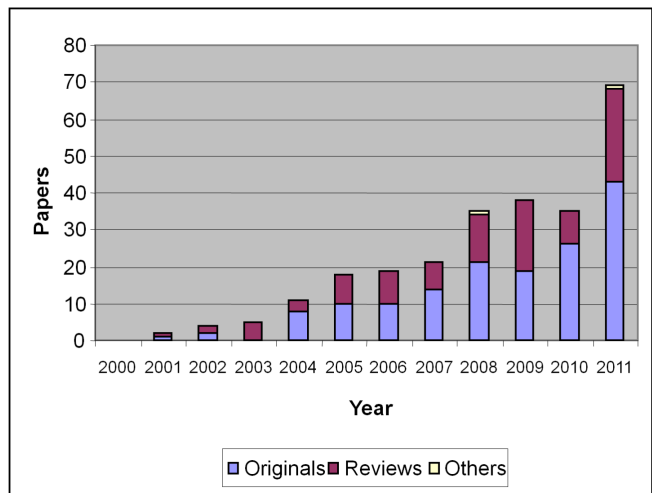


Figure 1. Bioengineering of dental tissue publications according to type and year. MEDLINE 2000-2011.

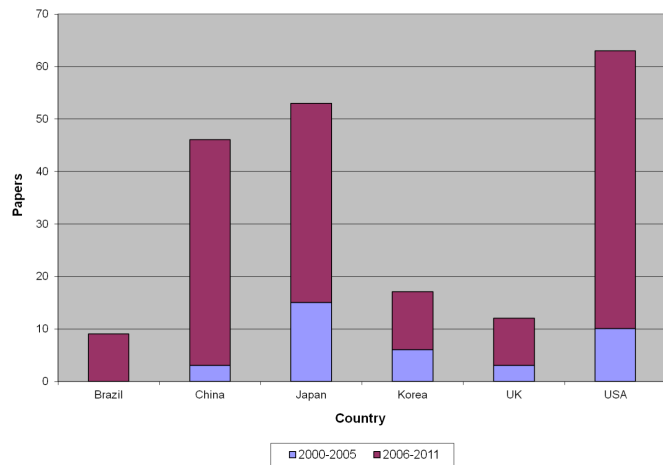


Figure 2. Articles associated with the terms “tooth regeneration” and “stem cells”. Distribution by country. MEDLINE 2000-2011.

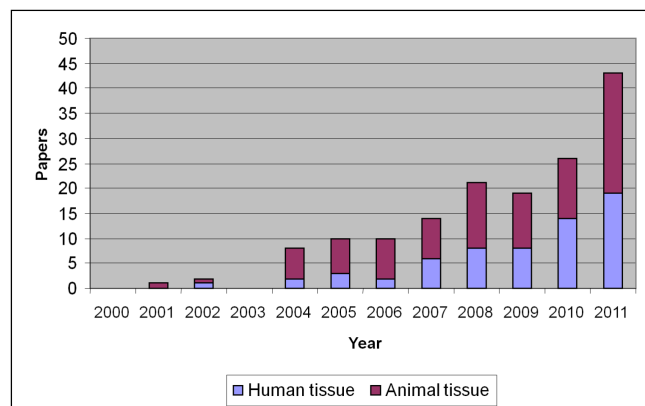


Figure 3. Original articles on bioengineering of dental tissue according to tissue source and year of publication. MEDLINE 2000-2011.

Of all the 154 original publications, 40.91% used human cells and 59.09% cells of animal origin. Distribution according to year is shown in Figure 3.

The journals with more publications were Fourth Military University (13), University of Tokyo (8), University of Michigan (8) and University of Southern California (8). Finally, the most productive authors were UedaM (17), Jin Y (11), Shi S (9), Mao JJ (7), Wang S (7) and Yelick PC (7).

Discussion.

A demanding task to significantly improve understanding of the increased evolution in dental tissue bioengineering is to connect authors and research groups from universities. This is known as *“chemical reactions”*¹² and together with research and development policies (R&D), it is essential in bibliometrics.

The case study was concentrated on 3 countries (The United States, Japan and China) which represent two thirds of the production. In Latin-America, only Brazil was present, presumably under a coauthorship system with the United States. The evidence is the investigations made by the Federal University of São Paulo in which Yelick PC, from the University of Tufts, Boston, participates as coauthor.

Considering country and author concentrations in the advancement in bioengineering of dental tissue, we may predict the growth during the next six years of our series, 2012-2017, will be larger compared to that observed for the period 2000-2006 and 2006-2011. This is due to the concentration and development of scientific cluster-growth patterns shown in other areas in early research^{12, 13}.

From another point, the presumption of exponential growth for publications associated with the term “stem cell” is already demonstrated, reaffirming this growth prediction¹⁴. Ueda M, sets trends and patterns to guide investigations, specially within the frame of literature reviews done by his collaborators.

The pending test is to inquire how public policies affect the development of scientific discoveries within a country. Jeffrey Furman, from Boston University, proved there are significant differences between the numbers of published articles depending on state policies in the United States¹⁵. Thus, we can extrapolate differences in the amount of articles released or the growth during the last six years and realize it is intimately related to new ongoing policies in each country.

On the other hand, it is worth analyzing cluster-growth patterns in order to strategically choose partners for multicentric studies or multiple-starting laboratories in the optimization of resources for testing new products.

This study presents limitations in establishing relations between bibliometrics and the possible impact of public policies on global research. However, there are assumptions previously referenced^{14, 15} which confirm their intimately related growth.

Within the local scope, Chile has neither publications nor study groups publishing in this field; therefore, bibliometric data becomes relevant to prepare an appropriate niche for such progress.

An open question to Chilean general healthcare reality is associated with funding and whether the efforts supporting investigation in sciences today have a real social return¹⁶.

Nowadays, the previously described situation represents an opportunity for Chile. It is an invitation to yield new cores of knowledge and money management for accelerating and gathering more evidence directed to create new products in dentistry.

Since Chile has a null participation in the scientific ecosystem today, they need this chemical reaction in order to build a robust system for scientific progress in the dental bioengineering field.

The extinct research group from the Mineralized Tissue Regeneration Laboratory at the Faculty of Dentistry from the University of Chile which worked until 2010 was vanguard. Nevertheless, they are a living sign proving that, without a system promoting research and development (R&D) in the short and medium term, it is impossible to achieve quality research and the impact to produce innovation and possibilities of industrialization from Chile towards the rest of the world.

For this reason, they should take the challenge of promoting and creating new medium and long term R&D policies and checking university internal protocols to allow and fund research focused on innovation and projecting social returns¹⁶.

The main invitation is for Chile to change the attention of their research in dentistry. Specifically, they can do it by creating a research cluster, not replicating other ideas, but starting robust industries of knowledge through international cooperation and short and medium term research focused upon innovation. This way, they can be known, not only in scientific journals, but also as final products for consumers from Chile and the world.

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