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NUMBER OF SCIENTIFIC RESEARCH CARRIED OUT IN TURKEY IN THE FIELD OF DENTAL MATERIALS: A SYSTEMATIC REVIEW

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Abstract

The purpose of this study was to review the scientific studies related to dental materials, which were conducted in Turkey between 1992 and 2017, and to assess the relationship between the patent amount and the scientific studies. The literature from January 1992 to December 2017 was scanned by two independent investigators using three different databases (Medline, Web of Science and Scopus). In addition, Patent Coverage Data Service and Espacenet Patent Search have been scanned for international and national patent collections. The titles and abstracts of all studies were examined. Laboratory, clinical studies and patents were included in the study, but reviews and case reports were not included. The full texts of the studies were analyzed when the titles and abstract sections were insufficient. Descriptive and quantitative analyses of the obtained data were performed. In the number of publications and citations related to dental materials, the United States ranks the first in the World and Turkey ranks the 11th and 10th, respectively. Among the universities in Turkey, Hacettepe University is ranked the first with 468 scientific studies and 8464 citations to their study. Despite the increase in the number of articles published in Turkey in the field of dental materials in recent years, the increase in the number of patents does not appear sufficient. The industry should lead to new technologies in the field of dental materials by working in cooperation with the Dental Departments.

Keywords: Dental materials, Innovation, Systematic review

INTRODUCTION

A number of approaches have been developed to restore the demineralization and the destruction of dental tissue. Dental materials have an important role in regaining the lost function of tooth structure [1-3].

In the 18th century, gold was the most preferred dental material because of its corrosion resistance and easy handling ability. With the use of gold in dentistry, the aesthetic expectation from dental materials began to increase as well as the expectation of function. In the 20th century, alloys of chromium, nickel, cobalt and titanium were used in dentures [4]. In addition, polymers became an alternative to almost all dental materials in this period. In the 21st century, the development of dental materials with the adaptation of advancing technology to dentistry continues rapidly [5].

Dental treatments can be divided into 3 categories as preventive, restorative and rehabilitation [2]. Preventive treatments include fluoride containing agents, fissure sealants and pulp capping agents to prevent the progress of decaying; dental materials such as synthetic resins, adhesive systems, amalgam and porcelain are used for the purpose of restoring the lost function or aesthetic due to decay or other reasons [6-9]. Functional deficits resulting from tooth extraction can be rehabilitated with dental materials such as artificial teeth, bridges or implants [10].

Besides evaluating the effectiveness of dental materials in the treatments, the scientific studies in the field of dental materials should pioneer the production of new dental materials. This is directly related to the qualities of the scientific works done, as well as to the importance given by the countries to Research and Development (R & D).

There have been many studies around the world in the field of dental materials up to the present day. The purpose of this study was to systematically review the scientific studies done in Turkey related to dental materials and to assess the contribution to Turkish economic system.

MATERIALS and METHODS

Systematic literature review

The Literature between January 1992 and December 2017 was reviewed by 2 independent investigators. Three different databases, Medline (Pubmed), Web of Science and Scopus were used for the literature review. In addition, Patent Scope Data Service (<http://www.wipo.int/patentscope>) and Espacenet Patent Search (<https://worldwide.espacenet.com>) were also scanned to search international and national patent collections. The search terms which used for searching of the articles and patents were Dental Materials, Dental Alloys, Dental Amalgam, Dental Cements, Compomers, Dentin-Bonding Agents, Resin Cements, Zinc Oxide-Eugenol Cement, Zinc Oxide Eugenol Cement, glass ionomer cement, Dental Implants, Dental Impression Materials, Dental Porcelain, Composite resins, Compomers, Pit and Fissure Sealants, Pulp Capping and Pulpectomy Agents, Pulp Capping Agents, Root Canal Filling Materials, Root Canal Sealants.

In addition, Endnote X7.7.1 software (Thompson Reuters, New York, United States) was used to avoid duplicating the same studies. The presentation of the systematic review was composed with the PRISMA Notification Checklist (www.prisma-statement.org).

Study selection

The titles and abstracts of all the studies were examined by two independent researchers. Initially, all literature related to dental materials were scanned for the study. Laboratory and clinical studies between 1992 and 2018 for the development and evaluation of dental materials, as well as patents in this period, were included in the study, but the reviews and case reports were not included. Full texts of the studies whose titles and summary sections were insufficient were analyzed.

Data Transformation and Analysis

SPSS Statistics 23.0 version (IBM Corporation, New York, USA) software was used to perform descriptive and quantitative analyses of the obtained data. The data were analyzed according to the number of publications, patents, and citations.

RESULTS

652,745 articles and 18,854 patents related to dental materials were obtained from data sources. 548,650 double counted or unrelated dental materials records were removed from the study. The suitability of 85,241 articles and 18,854 patents were evaluated. As a result, 81,281 articles and 13,244 patents were included in the review (Figure 1).

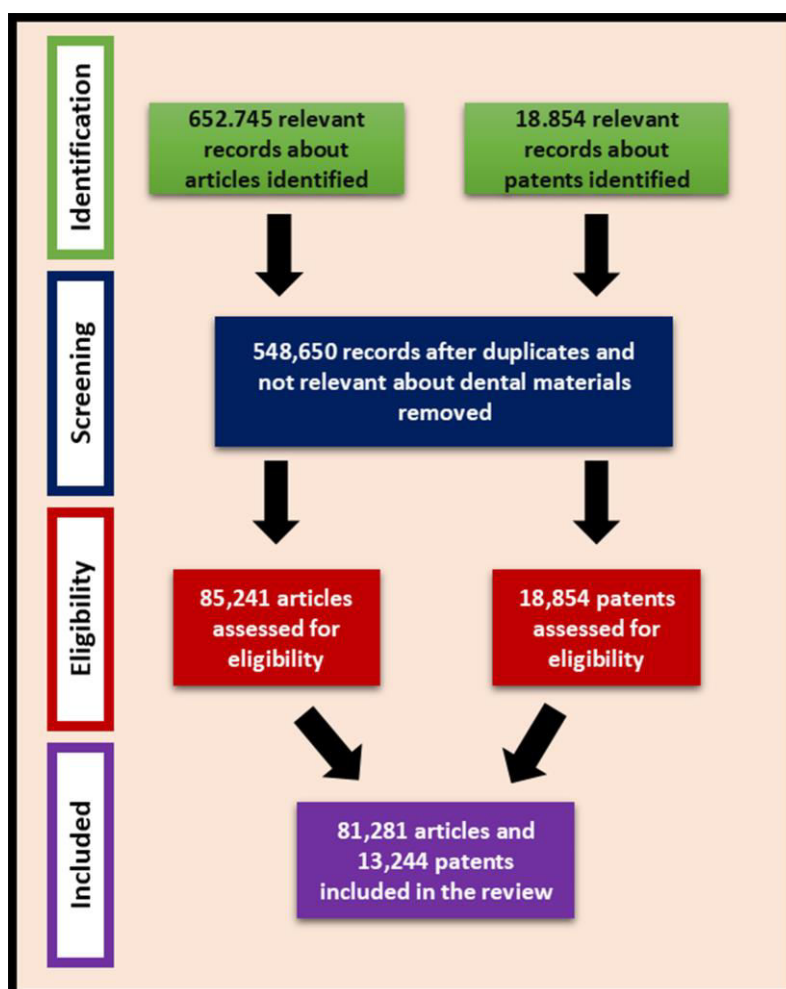


Figure 1: Search strategy followed for the review

The highest amount of articles on dental materials were published by The United States between 1992-2017. Respectively, the United Kingdom (14,783), India (10,070), Brazil (9,615), Germany (8,036) are the countries with the greatest number of studies on dental materials following the U.S.A. In Turkey, 3,254 articles were published in the field of dental materials.

According to the cited references to the studies, The United States is the first with 218,993. Respectively, United Kingdom (142,979), Brazil (115,996), Germany (92,479) and Japan (80,073) are the most cited countries. In Turkey, 36,331 studies were cited in the field of dental materials (Figure 3).

The United States (4,646) is the country with the most patents on dental materials. Respectively, Sweden (2642), Japan (1608), China (1041) are the countries with the greatest number of patents on dental materials following the United States. However, Turkey has 8 patents on dental materials (Figure 2).

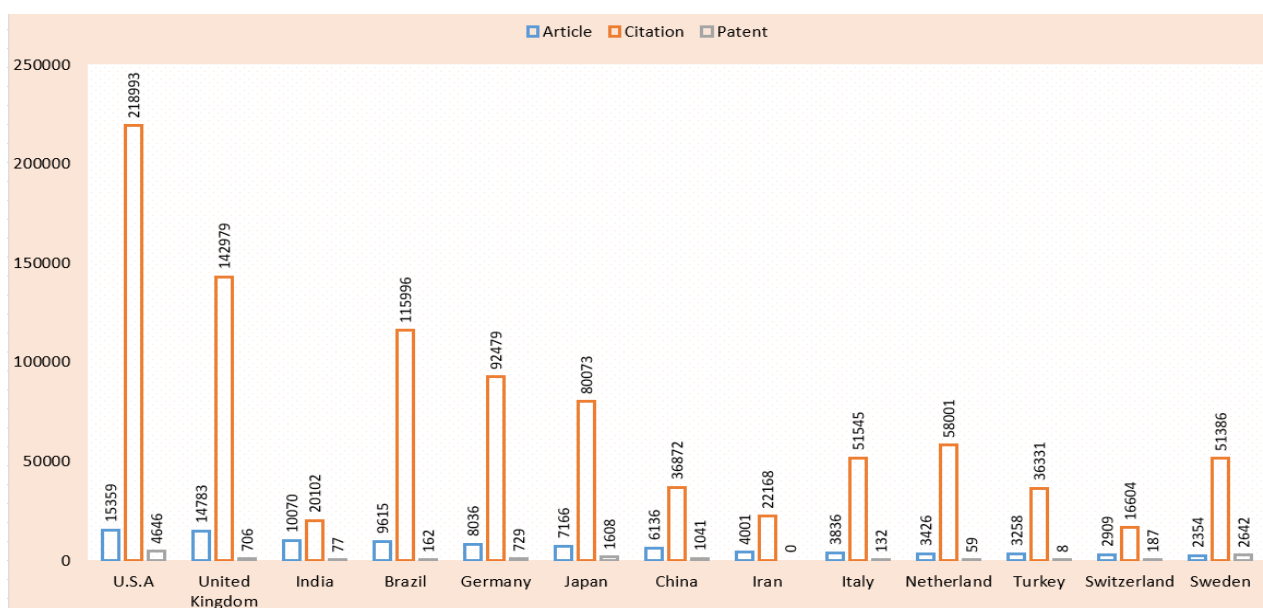


Figure 2: Ranking of the countries by article, citation and patent numbers

Hacettepe University (468) is the university that publishes the highest number of scientific articles in the field of dental materials in Turkey. Respectively, Gazi University (308), Istanbul University (287), Selcuk University (264), Ege University (262) are the universities with the greatest number of studies on dental materials following the Hacettepe University in Turkey (Figure 3).

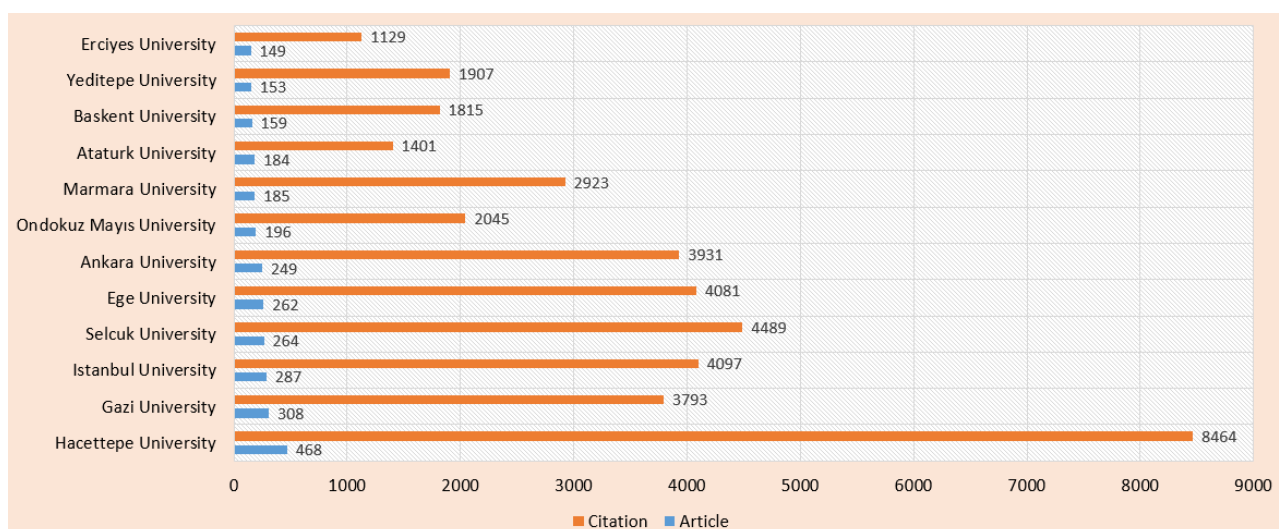


Figure 3: Ranking of the universities by number of articles and citations in Turkey

According to quantities of citations, Hacettepe University is the first with 8,464. Respectively, Selcuk University (4,489), Istanbul University (4,097), Ege University (4,081), Ankara University (3,931) have the most cited papers (Figure 4). In Turkey, the most cited papers are from Akkayan and Gülmez[11] (349 citations), Calt and Serper[12] (221 citations), Atsu, Kilicarslan[13] (186 citations), Sevimay, Turhan[14] (142 citations) (Figure 4).

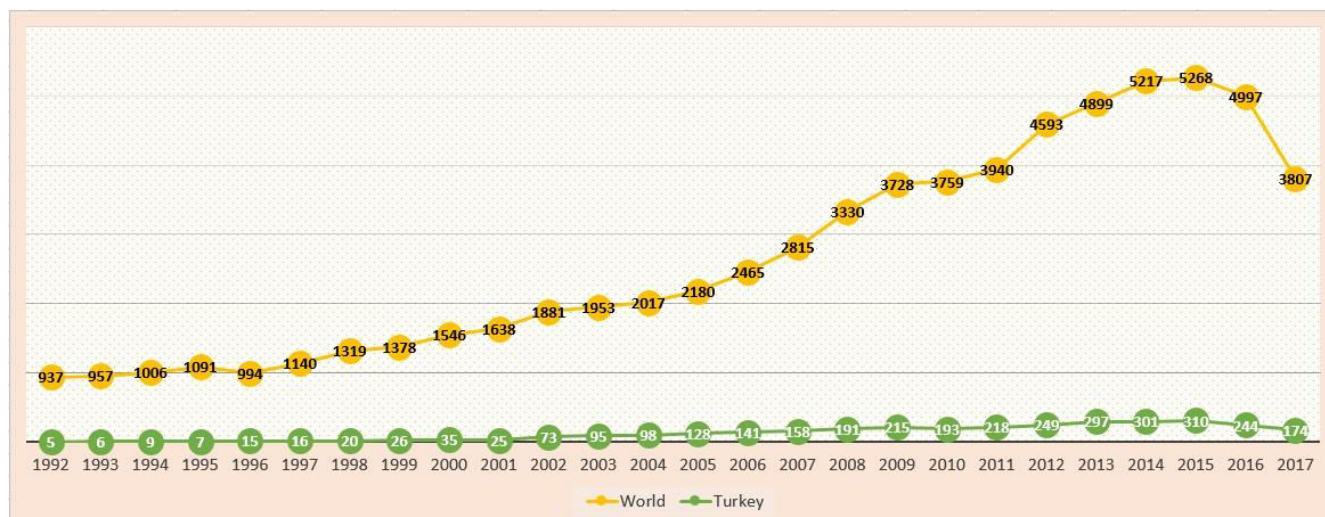


Figure 4: The distribution of the number of the articles published in the world and Turkey by years

The largest number of articles (5,268) in the world in the field of dental materials were published in 2015, and the fewest articles (937) were published in 1992. Likewise in Turkey, the largest number of articles (310) in Turkey were published in 2015, and the fewest articles (5) were published in 1992 (Figure 5).

Document Title	Authors	Year	Source	Cited by
Resistance to fracture of endodontically treated teeth restored with different post systems	Akkayan, B., Gülmez, T.	2002	Journal of Prosthetic Dentistry 87(4), pp. 431-437	349
Time-dependent effects of EDTA on dentin structures	Çalt, S., Serper, A.	2002	Journal of Endodontics28(1), pp. 17-19	221
Effect of zirconium-oxide ceramic surface treatments on the bond strength to adhesive resin	Atsu, S.S., Kilicarslan, M.A., Kucukesmen, H.C., Aka, P.S.	2006	Journal of Prosthetic Dentistry95(6), pp. 430-436	186
Three-dimensional finite element analysis of the effect of different bone quality on stress distribution in an implant-supported crown	Sevimay, M., Turhan, F., Kiliçarslan, M.A., Eskitascioglu, G.	2005	Journal of Prosthetic Dentistry93(3), pp. 227-234	142
Mechanical and physical properties of contemporary dental luting agents	Attar, N., Tam, L.E., McComb, D.	2003	Journal of Prosthetic Dentistry89(2), pp. 127-134	135
Effects of staining and bleaching on color change of dental composite resins	Villalta, P., Lu, H., Okte, Z., Garcia-Godoy, F., Powers, J.M.	2006	Journal of Prosthetic Dentistry95(2), pp. 137-142	127
The influence of occlusal loading location on stresses transferred to implant-supported prostheses and supporting bone: A three-dimensional finite element study	Eskitascioglu, G., Usumez, A., Sevimay, M., Soykan, E., Unsal, E.	2004	Journal of Prosthetic Dentistry91(2), pp. 144-150	125
Color stability of resin composites after immersion in different drinks	Ertas, E., Güler, A.U., Yücel, A.Ç., Köprülü, H., Güler, E.	2006	Dental Materials Journal25(2), pp. 371-376	123
The Effect of Surface Treatment on the Shear Bond Strength of Luting Cement to a Glass-Infiltrated Alumina Ceramic	Özcan, M., Alkumru, H.N., Gemalmaz, D.	2001	International Journal of Prosthodontics14(4), pp. 335-339	120
Flexural strength and fracture toughness of dental core ceramics	Yilmaz, H., Aydin, C., Gul, B.E.	2007	Journal of Prosthetic Dentistry98(2), pp. 120-128	119

Figure 5: The top ten most cited articles in the field of dental materials in Turkey

DISCUSSION

Dental materials have been an important factor in scientific studies in the field of dentistry. The most important reason for this is that dental materials are the basis of many treatments in dentistry. Along with the renewal of treatment approaches every day, the number of dental materials offered by producers to the market also increases. Many scientific studies are required to analyze the suitability of these new materials for treatment and to assess their performance [2, 5].

There is an increase in the number of scientific studies conducted in the field of dental materials worldwide. This increase in the number of scientific studies can be due to many factors (Share allocated for R & D expenditures, the number of qualified people to carry out scientific production, increase in the number of universities) [15]. In Turkey, according to Organization for Economic Co-operation and Development (OCED) data (2017), the budget allocated to R & D did not change significantly between the years 1992-2017 (1992:0,356%, 2017:0,882%) [16]. According to Bermek [17] and Balçı [18], one reason for the increase in the number of scientific studies conducted in Turkey in recent years may be due to the newly established state universities in Turkey. İnel [19] also indicates that the assignment based on academic publication criteria is the major cause of the rapidly increased number of scientific publications in Turkey. Also, the incentives given to international publications have increased the number of publications rapidly. As well as universities, TÜBİTAK encourages international publications by rewarding studies published in foreign scientific journals [20].

The quality of the publication is more important than the number of published articles. One of the important factors determining the quality of publications is the number of citations received. Although the number of publications in Turkey is much higher than in Sweden, it has been found that the number of articles cited in Turkey is fewer than Sweden. The reason for this is in academic upgrades in Turkey, the priority is given to the number of publications and the quality of publications may be ignored [15].

The majority of the universities, which ranked first in citation indexes, are located in metropolises like Ankara, Istanbul, and Izmir. One of the reasons for these universities to produce higher numbers of scientific studies is that they may have completed their institutionalization faster than the other universities. Furthermore, these universities have the advantage of being located in a metropolis where scientific activities (conferences, seminars) take place more intensively. Another reason is that the number of qualified faculty members in these universities is higher than in other universities [21].

The transformation of scientific research into economic gains has become more important in countries' politics than in the past. In order to achieve this, researchers and expenditures for the development of technologies for new products must be sufficient and effective [22]. Patents are of great importance in order to transfer the technical solutions obtained by the inventions to the industrial sector [23]. Schmookler [24] reported that patent statistics are a more satisfactory measure of the degree of technological development in countries compared to other indicators. In addition, the OECD accepts patent as the most favourable indicator of innovation.

One reason for the lack of patents relevant to dental materials may be the fact that national patent protection is preferred in Turkey. The high expense of international patent protection may have led to the preference of national patent protections. If inventors are provided with adequate support from the industry, they will be able to withstand this high cost and there may be an increase in the number of international protected patents in Turkey [25].

In Turkey, there is no parallelism between the increase of scientific studies in recent years and the patent statistics. One of the reasons for this may be the fact that the state does not allocate sufficient budget for R & D expenditure. According to OECD data (2015), Turkey is ranked the 35th among the world's countries on gross domestic spending allocated to R & D budget (0.882%, 15,692 million dollars) [16]. However, with the increase of R & D spending; competition, growth and employment will be enhanced in the country.

That universities and companies are not in sufficient co-operation may be another reason for the lack of patents relevant to dental materials in Turkey. University-industry cooperation is one of the most important ways in which knowledge can be transformed into production. As a result of this cooperation, the technological know-how needed by the industry can be obtained from the universities [26].

CONCLUSION

1. In Turkey, from 1992 to the present day, there has been an increase in the number of scientific studies conducted in the field of dental materials. However, the fact that the inadequate number of cited papers indicates that the quality of studies should be taken into consideration. In order to increase the number of quality publications, the academic promotion concept based on the number of academic publications should be changed.
2. Patents are the most important indicators of the development of countries' technology. If the industry works in collaboration with the faculties of dentistry, it will lead to the production of new technological products in the field of dental materials in Turkey.

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