# Status of Innovations in Global Dentistry Over 150 Years Using Patent Landscaping Analysis

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**Abstract**

Doing something new which results in the improvement of a product, procedure, or service is termed Innovation. In dentistry, different kinds of innovations have been protected under patent laws on a global scale. The main objective of this study is to provide an analysis of the patenting activities and recent patenting trends in the field of dentistry worldwide. In this study, the information regarding patents and patent applications related to dentistry was retrieved and analyzed by an online tool from the website www.lens.org . The Cooperative Patent Classification (CPC) with A61C code which denotes dental-related patents was chosen for this particular study. In the present study, we have analyzed and scrutinized worldwide data on patents in relation to dentistry from the year 1873 to 2023 which provides an analytic depiction of the dental patent landscape of over 150 years. According to the analysis, 69 granted patents were recorded in 1873 and gradually it increased with time. The maximum number of granted patents related to dentistry was recorded in the year 2021 (8749 patents). According to our study, A61Q11/00 code is the topmost trend in the field of dental inventions which denotes oral care products like toothpaste, mouth rinses, etc. According to this study, the majority of the patent applicants and patent owners were from various companies across the globe as compared to individual inventors or institutions, or universities. Among the top ten owners of dental patents, only one university has been able to be on that list.

Keywords: Innovations, Dentistry, Patenting, Online tool

## 1. Introduction

There is an excellent saying by a physicist that "We cannot solve our problems with the identical thinking we used after we created them" [1]. Therefore, we create new kind of solutions or any improvement to the prevailing problem. Having new ideas, innovating new techniques of implementing things and upgrading the existing course of action have always been an individual tendency. Doing something new which results in improvement of a product, procedure or service is termed Innovation [2]. Invention is the base for innovation. An invention is an advanced solution of the technical issues and may be safe guarded through patents. A patent is an especial right granted for an invention, which may either be a product or a procedure that contributes a new course

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of action or provides new scientific solution to a problem [2]. A patent provides exclusive ownership of the invention to the patentees and prohibits any other person or company from manufacturing, utilizing or vending the invention for a specific time period [3,4]. Patent schemes have demonstrated positive results in development of many countries [5,6]. In the recent times, there are various patent office databases that provide either free access or subscription access to the global patent data records [7]. The various patent office databases provide patent information as a public expedient so that the technical and science related problems can be solved in a more constructive, systematic and comprehensive way. Various inventions have been created in the field of health and most of them are protected by Intellectual Property (IP) rights [8]. Utilizing these patent records, various patent analyses have been done to find novel solutions to various technological problems. A patent landscape analysis can be defined as a futuristic patent search that provides a symbolic or diagrammatic depiction of information from search results to demonstrate leading patent grantees, latest patenting trends, technological evaluations, alliance partners etc [9]. In dentistry, different kinds of innovations have been protected under patent laws on a global scale. The main objective of this study is to provide an analysis of the patenting activities and recent patenting trends in the field of dentistry worldwide.

## 2. Materials and methodology

There are various patent search and analysis databases globally which provide free access like Lens.org, Google patents, USPTO (United States Patent and Trademark Office), Free Patent online (FPO) etc. [10]. In this study, the information regarding patents and patent applications related to dentistry were retrieved and analysed by a tool from the website www.lens.org . This website provides worldwide patent related and academic knowledge as an open resource to enhance the efficacy in solving science and technology enabled problem [11,12] and serves over 225+ million scholarly works, over 127 million global patent records [13]. It is one of the largest patent search databases with such vast collection of scholarly works [14]. Generally patent search is done using certain keywords. But for this study, uniquely a combination of keywords and classification explorer was used for more accuracy. The keywords which were chosen were "dental and dentistry". The Cooperative Patent Classification (CPC) was considered for this particular study, as it is more precise and accurate [15, 16]. The A61C code, which denotes to dental related patents, was chosen. So the combination was A61C code, dental and dentistry. The date filter is set from the year 1840 to 2023 to generate data.

## 3. Results

A total of 5,07,268 patent records were displayed as a result of patent search done based on CPC classification code (A61C) and keywords like dental and dentistry at www.lens.org as on January 4th, 2023. The results of the patent landscaping analysis were demonstrated and elaborated according to the parameters chosen.

### Dental patent documents from 1873 till 2023

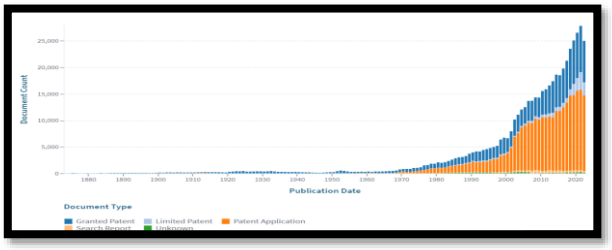


*Figure 1: Dental patent documents from 1873 till 2023*

Figure 1 is a stacked bar diagram, which demonstrates the dentistry related patent documents from 1873 to 2023. According to the analysis, 69 granted patents were recorded in 1873 and gradually it increased with time. Maximum number of granted patents related to dentistry (dark blue bar) were recorded in the year 2021 (8749 patents). In 2022, a total of 7815 dental patents had been granted till date ( January 14, 2023).

### Dental patent documents by type

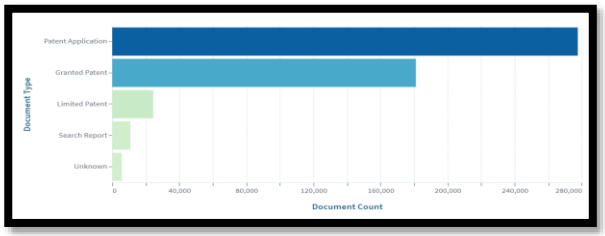


*Figure 2: Dental patent documents by type*

Figure 2 is a bar chart displaying the number of dental patent documents by type. According to the analysis, while 1,81,054 dental patents had been granted, there were still 2,77,569 dental patent applications are pending for grant. Other document type are as follows 24407 limited patents, 10754 search reports and 5673 unknown documents.

### Dental patent documents according to legal status

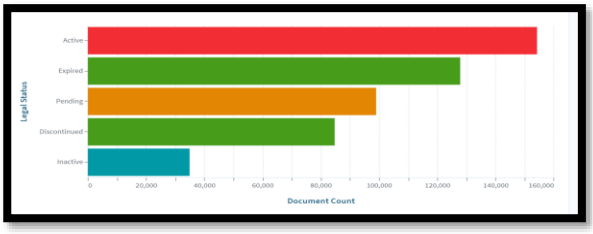


*Figure 3: Dental patent documents according to legal status*

Figure 3 shows a bar chart describing the number of dental patent documents according to legal status. As a result of this analysis 1,54,245 dental patent documents were recorded active, 1,27,865 expired,

98995 pending, 84767 discontinued and 34952 inactive.

## Top 10 dental patent applicants across the globe


*Figure 4: Top 10 dental patent applicants across the globe*

In Figure 4, this logo grid displays aggregation of top 10 dental patent applicants worldwide by patent document count related to dentistry. The Colgate Palmolive Company tops the chart with 8195 dental patent documents followed by 3M Innovative Properties Company with 5973 patent documents, Procter & Gamble (3995), G C Dental Ind Corp (3649), Ivoclar Vivadent Ag (3317), Align Technology INC (3309), Kaltenbach & Voigt (3184), Sirona Dental Systems Gmbh (2423), Dentsply Int INC (2360) and Braun Gmbh (1916).

## Top 10 owners of dental patent documents across the globe


*Figure 5: Top 10 owners of dental patent documents across the globe*

Figure 5 illustrates a logo grid depicting the collection of top 10 owners of dental patent documents globally by patent documents count. 3M Innovative Properties Company tops the list with 2038 patent documents followed by Align Technology INC with 1773 patent documents, Colgate-Palmolive Company (1223), Ivoclar Vivadent Ag (1189), Koninklijke Philips NV (870), The Procter & Gamble Company (728), Rutgers the state university of New Jersey(652), Ecolab Usa INC(642), Nobel biocare services Ag(638) and Dentsply Sirona INC (624)

## 3.6 Top 10 dental related CPC Classification codes

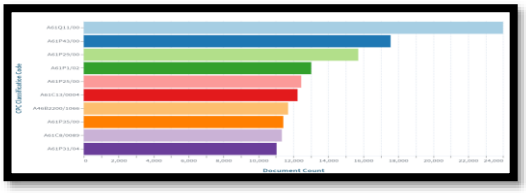


*Figure 6: Top 10 dental related CPC Classification codes*

Figure 6 displays a bar chart describing the top 10 dental related CPC classification codes according to usage. A61Q11/00 (23995 documents) is the numero uno in CPC classification codes followed by A61P43/00 (17,563 documents), A61P29/00(15711), A61P1/02(13021), A61P25/00(12449), A61C13/0004(12236), A46B2200/1066(11695), A61P35/00(11422), A61C8/0089(11339) and A61P31/04(11038).

## 3.7 Top 10 Jurisdictions assorted as per dental patent documents

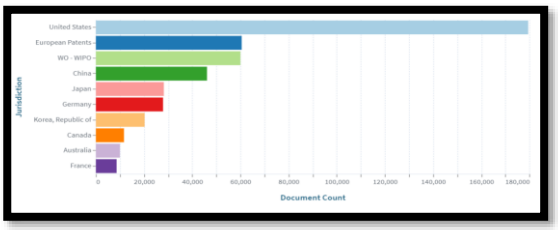


*Figure 7: Top 10 Jurisdictions assorted as per dental patent documents*

In Figure 7, the bar chart exhibit the top 10 jurisdictions assorted as per number of dental patent documents. United States reserves the top position with 179446 documents followed by European patents (60520),WO-WIPO with 59993 documents, China- 46125, Japan- 28202, Germany- 27878, Korea- 20225, Canada- 11662, Australia- 9,973 and France- 8,603.

# 4. Discussion

In recent scenario, a patent landscaping is an essential and reasonable tool for authentication of patent database [17, 18]. Some of the objectives of patent search is to analyse the evolution of a specific technology, to find the patent works of a distinguished scholar and gaining information regarding the latest inventions [7]. The importance of establishing the legal status of a patent is crucial for appreciating the worth, insight and the risks associated with the patent [19, 20]. Patent search is a very important tool to evaluate the financial returns on an innovative business investment. Information on legal status of a patent is of significant importance during target setting in case of licensing, trading or transfer of technological rights [21].

Earlier very few studies have been done in the field of dentistry where patent landscape analysis has been performed such as a study on patent documents relevant to dental caries in primary teeth [3] and a critical analysis of dental patents from 2005 to 2009 in Indian scenario [5]. In the present study, we have analysed and scrutinized worldwide data on patent in relation to dentistry from the year 1873 to 2023 which providing an analytic depiction of dental patent landscape of over 150 years. Based on the results of our study, the number of patent documentation was insignificant until 1920's, but a gradual increase in the documentations of patents was noticed afterwards. Till date, there are 2,77569 patent applications are under process and yet to get grant. This indicates that, in near future many newer inventions are going to be introduced into the field

of dentistry which can witness the changing face of the dental world.

Patent landscape analysis provides a glimpse of a jurisdiction's input to the world invention map. According to top 10 jurisdictions, United States tops the chart with 1,79446 dental patent documents followed by European patents (60520),WO-WIPO with 59993 documents, China- 46125, Japan- 28202, Germany- 27878, Korea- 20225, Canada- 11662, Australia- 9,973 and France- 8,603 patent documents. Bijle et al [5] concluded in his study that there was very less contribution of Indian inventors to dentistry as compared to international inventors and similar result was found in our study as IPO (India Patent office) has only 172 dental related patent documents.

The CPC code helps in limiting a patent search to a particular technical domain and restricts the number of patent search results [22]. The significance of CPC classification code analysis helps by estimating the product or technology which has highest commercial value for which maximum related patents have been filed. According to our research, A61Q11/00 code is the topmost trend in the field of dental inventions which denotes oral care products like toothpastes, mouth rinses etc. One should understand the trends and should know the potentiality of a technology before going for commercialization so that it will give the competitive edge.

According to a previous study by Bijle et al, majority of the patent applicants and patent owners were from various companies across the globe as compared to individual inventors or institutions or universities [5] and the same results were also observed in our study. Among the top 10 owners of dental patents, only one university has been able to be in that list (Rutgers the State University of New Jersey).

## 5. Conclusion

The overall result from this study implies that more the number of inventions and thus more patents are highly required for a bright future of dentistry globally. The level of research and development in the world needs to be boosted up. More continuing dental education programs needs to be conducted for increasing awareness among dentists regarding research and development, intellectual rights, technology transfer etc. An increase in patents and patenting in dentistry is obviously going to be beneficiary to dentists, traders and eventually to the patients.

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