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빅 데이터를 이용한 임플란트에 대한 관심도 분석: 웹 기반 연구

Analysis of interest in implant using a big data: A web-based study

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Purpose: The purpose of this study was to analyze the level of interest that common Internet users have in dental implant using a Google Trends, and to compare the level of interest with big data from National Health Insurance Service. **Materials and methods:** Google Trends provides a relative search volume for search keywords, which is the average data that visualizes the frequency of searches for those keywords over a specific period of time. Implant was selected as the search keyword to evaluate changes in time flows of general Internet users' interest from 2015 to 2019 with trend line and 6 month moving average. Relative search volume for implant was analyzed with the number of patients who received National Health Insurance coverage for implant. Interest in implant and conventional denture was compared and popular related search keywords were analyzed. **Results:** Relative search volume for implant has increased gradually and showed a significant positive correlation with the total number of patients (P<.01). Interest in implant was higher than denture for most of the time. Keywords related to implant cost were most frequently observed in all years and related search on implant procedure was increasing. **Conclusion:** Within the limitations of this study, the public interest in dental implant was gradually increasing and specific areas of interest were changing. Web-based Google Trends data was also compared with traditional data and significant correlation was confirmed. (J Korean Acad Prosthodont 2021;59:164-72)

Keywords
Big data; Dental implants; Dentures; Health information systems; Internet

Introduction

A major development in dentistry has been the successful use of osseointegrated implants to replace the natural teeth. The use of dental implants for oral reha-

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bilitation of edentulous patients has greatly expanded the range of dentistry, presenting various treatment options in complex cases in which functional rehabilitation was previously limited or insufficient.[1] The long-term success and predictability of dental implants have been well documented in both fixed and removable prostheses. In previous studies, dental implant showed high clinical success rates and patient satisfaction, regardless of the type of prosthesis.[2-5]

Also in Korea, National Health Insurance coverage for dental implant was first started in 2014, and the number of patients applied is gradually increasing. For this reason, as dental implant become popular, the public's interest in implant is also growing rapidly.[6] However, the assessment of patient factors associated with implant was mostly limited to postoperative satisfaction or success rate.[7,8] In general, preferences for various implant prosthetic methods have been studied, however, there is lack of research on the perception or interest that the general public has in the dental implant.[9,10]

As the technology of modern society develops, the Internet has become a major source of information in personal life.[11] When people need information, they can type search words into the Internet search engine and get the information easily and quickly. According to the announcement by the International Telecommunication Union in 2020, one-third of the world's population now uses the Internet, and the number of users continues to increase.[12] Especially in Korea, with the rapid development of information and communication technology and the widespread of smartphones, the Internet is very common in everyday life.

Google (Google LLC, Mountain View, CA, USA) is the most popular search engine in the world and offering Google Trends, a big data site that allows users to check the frequency of keyword or term searches using the Google search engine.[13] Google Trends is a useful tool to show how search volumes for specific keywords change over time and how they differ depending on the region. In addition, Google Trends allows users to enter up to five search keywords at a time, so users can compare trends between each keyword. Therefore, Google Trends based service could evaluate the responses to keywords in each region, including what keywords people are interested in, how the keywords have changed over time, and what related search terms they have.[14]

Also, medical information that can be used as a big data for health care could be downloaded conveniently and easily through the Healthcare Bigdata Hub system provided by Health Insurance Review and Assessment Service in Korea. The Healthcare Bigdata Hub system provides public data that could be analyzed by anyone, and ensures free utilization, including the use of profit-making purposes.

The health and medical sector has been considered as a representative area to utilize a big data, due to its high volume, diversity, and complexity. In previous studies, researchers discussed the potential use of Google Trends in healthcare and medicine, including the prediction of disease.[15,16] However, perception of the availability and importance of a big data in the field of dentistry has been low so far, and few specific researches have been conducted, especially in dental implantology.

Therefore, the purpose of this study was to analyze the level of interest that common Internet users have in dental implant and report the related search keywords using a Google Trends. Also, the study compared the level of interest with big data from National Health Insurance Service.

Materials and methods

This study did not require approval from the local institutional review board because it used only publicly available data. A Google Trends provides data on Internet search patterns by analyzing some of all web searches on Google Search websites and other affiliated Google sites. Users or researchers are able to download analysis results for searches to perform further studies. The portal calculated the proportion of searches for a user-specified

keyword among all searches performed by Google search engines. Then, it provides a relative search volume (RSV), which is the average data that visualizes the frequency of searches for those keywords over a specific period of time.[17] Users can specify the geographical distinctions according to city, state, or country for analysis. In addition, users can choose the research period, ranging from January 2004 to the present, divided by months or days. Researchers are also able to specify up to five keywords at the same time and compare the RSV for a particular search keyword between geographic areas or over time. Furthermore, Google Trends allows users to select specific topic categories to limit the search.[18]

In this study, the settings for Google Trends are as follows. First, the research period was set from 2015 to 2019 for five years. Next, the geographic area was set up as the Republic of Korea, and the topic category was health. Finally, the web search mode was selected. Google Trends uses a relative search index that standardizes randomly collected search volumes. Since there would be some differences in each search, the average of RSV was used after entering the search keyword twice. In addition, the average value was obtained by searching in April and October 2020, respectively.

The word Implant in Korean was selected as the search keyword to evaluate changes in time flows of general Internet users' interest from 2015 to 2019. Then, comma separated value data files for each month has been extracted and visualized. In addition, linear trend lines and six-month simple moving averages were inserted using software (Excel 2010, Microsoft Corp., Redmond, WA, USA) to evaluate time series variations.

Next, the number of patients who received the first stage of National Health Insurance coverage for implant was calculated on a monthly basis from January 2015 to July 2019 using the Healthcare Bigdata Hub system to compare the data values obtained from Google Trends with the actual number of claims for implant. Google Trends provides 4 to 5 days of data each month. Therefore, the mean of each data was set to the data values for the month. Pearson correlation analysis was performed on the RSV of the month and the total number of patients who received the National Health Insurance coverage for implant.

The interest in implants was compared with the conventional denture. The search keywords were Implant and Denture respectively, comparing RSV and setting a linear trend line. Pearson's correlation analysis was conducted for RSV over a month to evaluate the relationship between implant and denture searches. Statistical analysis was performed with software (SPSS version 20.0, IBM Corp., Armonk, NY, USA) and statistical significance was set at $P < .05$.

Google Trends presents popular related search terms for the keyword. Based on related search terms, researchers could identify trends in what users who search implant also search for. From 2015 to 2019, after searching the implant for each year, related search terms were collected and the top 10 search terms were analyzed. Each search term was classified into four groups, and the RSV for each group was scaled and analyzed according to the year (Table 1).

Table 1. Related search keyword groups

Group	Related search keyword
Implant cost (IC)	Implant cost, implant price, molar implant price, implant insurance cost, Osstem implant price
Implant brand (IB)	Osstem implant, Dio implant, Implant company, Point implant
Implant procedure (IP)	Implant procedure, implant denture, anterior implant, molar implant
Implant longevity and complications (ILC)	Implant longevity, implant complications, implant pain

Results

RSV for implant has increased gradually since 2015 to 2019, given the linear trend line and six month moving averages (Fig. 1). The maximum value of RSV was 77 and recorded on August 25, 2019. The minimum value was 26 and found on June 7, 2015. The average of RSV was 51.26 and the standard deviation was 9.69.

RSV of the month for implant and total number of patients who received the National Health Insurance coverage for implant has both shown a gradual increase over the year (Fig. 2). RSV of the month was the highest at 68.68 in March 2018. The total number of patients was the highest at 81061 in July 2018, with an increase in July every year.

For January 2015 to July 2019, Pearson correlation analysis was performed on the RSV of the month and the total number of patients. Pearson correlation coefficient was 0.521, indicating a statistically significant positive correlation (Table 2).

The RSV and linear trend line for implant and denture were compared (Fig. 3). The average RSV of denture was 13.54 with a standard deviation of 4.66. The RSV of denture was the highest at 28.25 in May 8, 2016. It was 3.5 in August 16, 2015. The RSV for implant was higher for all dates. No significant change in linear trend line for denture was observed, and a certain level was maintained regardless of year. Pearson correlation analysis was also performed on the RSV for implant and denture, with no statistical significance (Table 3).

The percentage of RSV for each related search keyword group is as follows (Fig. 4). Group Implant cost (IC) showed the highest value for all years. Groups IC decreased from 50.89% in 2015 to 34.81% in 2019, and Group Implant procedure (IP) increased from 10.36% to 32.80%. Group Implant brand (IB) and Implant longevity and complications (ILC) were approximately 10 to 20%.

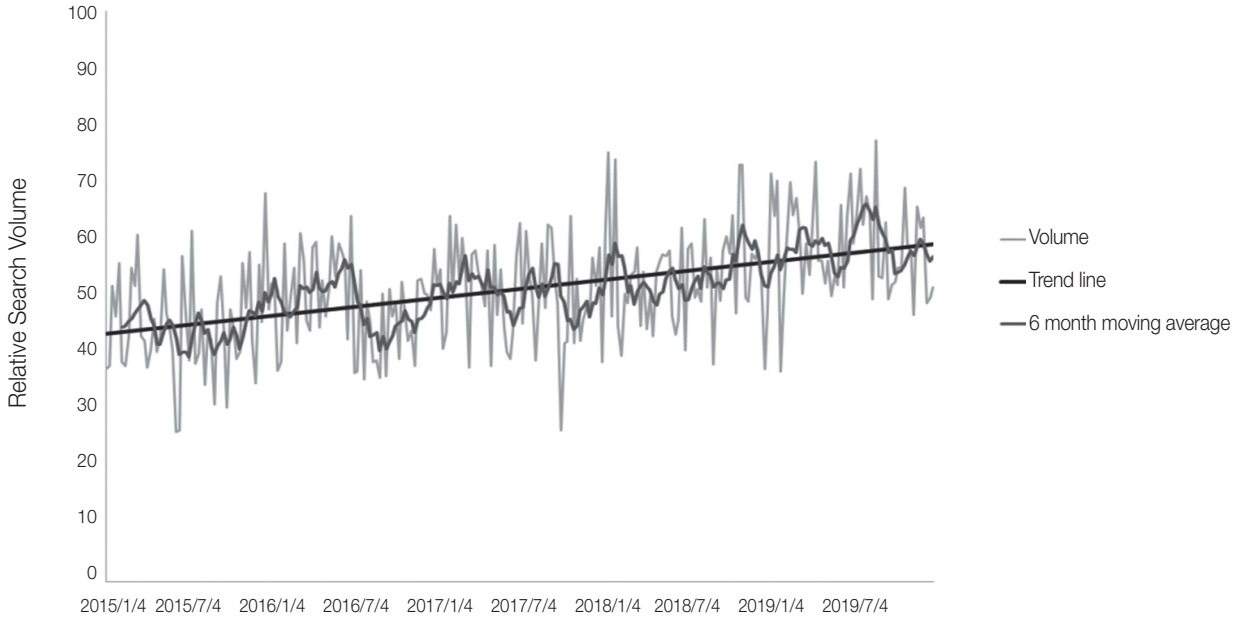

Fig. 1. Relative search volume, linear trend line, and 6 month moving average for implant.

Fig. 2. Relative search volume of the month and the total number of patients.

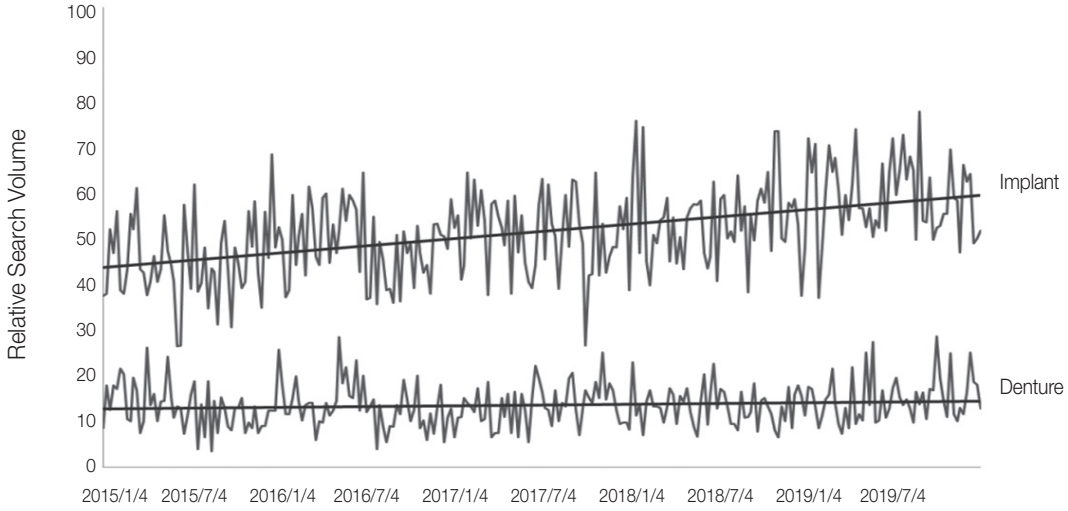

Fig. 3. Relative search volume and linear trend line for implant and denture.

Table 2. Pearson correlation analysis for relative search volume of the month and the total number of patients

Correlations			
		Relative search volume	Total number of patients
Relative search volume	Pearson Correlation	1	.521*
	Sig. (2-tailed)		.000
	N	56	56
Total number of patients	Pearson Correlation	.521*	1
	Sig. (2-tailed)	.000	
	N	56	56

*: Correlation is significant at the 0.01 level.

Table 3. Pearson correlation analysis for implant and denture

Correlations			
		Implant	Denture
Implant	Pearson Correlation	1	.112
	Sig. (2-tailed)		.072
	N	261	261
Denture	Pearson Correlation	.112	1
	Sig. (2-tailed)	.072	
	N	261	261

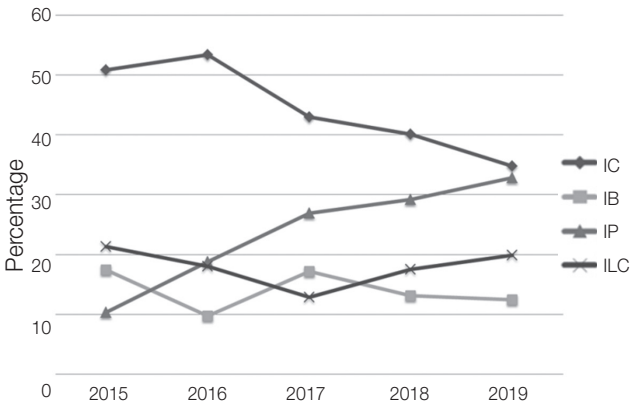

Fig. 4. The percentage of relative search volume for each related search keyword group. IC: implant cost, IB: implant brand, IP: implant procedure, ILC: implant longevity and complications.

Discussion

The present study analyzed the level of interest in implant using Google Trends and compared the level of interest with big data from National Health Insurance Service. Health and medical big data has been collected from both the public and private sectors, and data with significant scale and diversity is being built, especially based on the use of high levels of information and communication technology. A common method to get the data needed for epidemiological research is to examine and classify the accumulated clinical data one by one, which requires a lot of time and manpower. An Internet data based approach has presented new possibilities for solving complex problems that have been difficult to deal with conventional research methods. Recently, The National Academy of Medicine approved the use of Internet data in health care research. Internet data is easily accessible to anyone, and as time goes by, data is accumulated and organized.

As a result of the RSV analysis, interest in implant showed a gradual increase, which could be seen through the linear trend line and 6 month moving average. As reported in previous study, this is attributed to the expansion of insurance coverage for implant, improved public awareness of implant, and increased accessibility.[19] Also, considering the trend, public interest in implant is expected to increase further in future. However, currently, the information available from web searches related to implant is limited, most of which are dental advertisements and promotional articles. Therefore, efforts by clinicians or dental associations will be required to ensure that the general public can obtain quality information about implant on the Internet.

In this study, there is a limitation that the number of implant patients cannot be accurately collected, given that the Healthcare Bigdata Hub system only provides patients who received the National Health Insurance coverage for implants. However, with the increasing use in the insurance coverage for implant, the overall trend of implant patients could be predicted. Since the standard of National Health Insurance coverage for implant is July of each year depending on age, the number of insurance application increased greatly in July every year. The Pearson correlation coefficient between the RSV and the total number of patients was 0.521, which could be considered to show a modest or moderate positive correlation.[20] As reported by previous study, these results suggest that the RSV can be used similarly to predict public demand and interest for implant.[21] Several studies have compared Google Trends with traditional reliable data sets and reported moderate to strong strengths of association, which means that Google Trends data can be used to analyze health-related phenomena.[22,23]

In partially or fully edentulous patients, conventional denture has been the main choice of treatment for centuries. Compared to conventional denture, implant-supported prosthesis offer superior results for esthetics, phonetics, function, and comfort for the patients.[24] Also, implant assisted or supported denture shows improved satisfaction and success rate.[25] According to the analysis of public interest in implant and denture, interest in implant was higher than denture, regardless of year. In addition, the level of interest in denture has not changed

significantly over time. These results could have been affected by the relatively young age group of Internet users. Nevertheless, as a treatment option for edentulous patients, it could be assumed that the public interest in implant is increasing, and that the gap between denture is widening over time. The significant increase in interest in implant treatment in recent years has been attributed to a change in perception of implant and an increase in the number of qualified providers.[26]

According to the RSV analysis, the most frequent related search keyword for implant was implant cost in all years. As reported previously, cost and associated factors are one of the most relevant reasons for choosing or rejecting treatments for both fully and partially edentulous patients.[27,28] Also, treatment fees have a greater impact on utilization than on demand.[29] The frequency of searches for implant procedure increased in 2019 compared to 2015. This means that as implant become more popular, interest in the surgical or prosthetic procedure of implant is gradually increasing. Therefore, these aspects should be considered in consultation with patients or in the choice of treatment options.

However, the major limitation of Google Trends study is the lack of accurate information about how Google generates search data and its algorithms. It is also difficult to assess the change in the interface and functionality of Google Trends over time, which may lead to variation in the search results and, therefore, changes in research results. Google Trends searches, even under the same conditions and points in time, also result in some differences each time they are analyzed. Therefore, a large number of searches should be performed to obtain the average value. Data reliability could be insufficient in this study because only four searches were made under the same conditions. Also, since Google ranks third in terms of Internet search engine market share in Korea, Google's search results cannot accurately represent the interest of the general public in Korea. In addition, all searches are calculated on Google Trends, such as searching for social issues and specific academic information. Cook *et al*.[30] suggested that Internet search study may work well on keywords with less media exposure because media reports affect search trends which can increase non-patient searches that do not reflect actual activity. Further studies are needed to evaluate the validity of Google Trends for surveillance in prosthetic dentistry and how big data will be used as valuable research data. In the future, a big data on the Internet, including a Google Trends, will be appropriately selected and interpreted, making it a major data resource for prosthetic dentistry.

Conclusion

The present study confirmed that the public interest in dental implant was gradually increasing and specific areas of interest were changing. It also compared web-based Google Trends data with conventional data, and there was a significant correlation.

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빅 데이터를 이용한 임플란트에 대한 관심도 분석: 웹 기반 연구

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목적: 본 연구는 구글 트렌드를 이용하여 일반적인 인터넷 사용자들이 치과 임플란트에 대해 가지고 있는 관심도를 분석하고, 관심도의 수준을 국민건강보험공단의 빅 데이터와 비교하기 위함이다. **재료 및 방법:** 구글 트렌드는 검색 키워드에 대한 상대적 검색 볼륨을 제공하는데, 이것은 특정 기간 동안의 검색 빈도를 시각화하여 보여주는 평균 데이터이다. 임플란트를 검색어로 선정하여, 2015년에서 2019년까지의 일반적인 인터넷 사용자들의 관심도를 추세선과 6개월 이동평균선을 이용하여 분석하였다. 다음으로, 임플란트에 대한 상대적 검색 볼륨을 국민건강보험의 적용을 받아 임플란트를 식립한 환자 수의 변화와 함께 비교하였다. 임플란트와 전통적인 의치에 대한 상대적 관심도를 비교하였으며, 임플란트와 관련된 주요 연관 검색어를 분석하였다. **결과:** 임플란트에 대한 상대적 검색 볼륨은 점진적으로 증가하였으며, 국민건강보험 혜택을 받은 환자 수와 유의한 양의 상관관계를 보였다 ($P < .01$). 임플란트에 대한 관심도는 모든 기간에 있어서 의치에 비해 높았다. 연관 검색어로는 임플란트 비용이 가장 빈번하게 관찰되었으며, 임플란트 과정에 대한 검색이 증가하였다. **결론:** 본 제한된 연구의 결과를 근거로, 임플란트에 대한 대중의 관심은 점진적으로 증가하고 있으며, 관심의 세부 분야는 변하고 있다. 또한 웹 기반의 구글 트렌드 데이터를 전통적인 방식의 데이터와 비교한 결과, 유의한 상관관계를 확인할 수 있었다. (대한치과보철학회지 2021;59:164-72)

주요단어
빅 데이터; 치과 임플란트; 의치; 의료 정보 시스템; 인터넷

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