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RESEARCH ARTICLE

EXPEDITE DENTISTRY GO DIGITALIZED-A SYSTEMIC REVIEW AND META ANALYSIS

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ABSTRACT

Background: In Dentistry digitalization is less when compared with other fields. Especially in India when compared to other countries. The purpose of this article is to evaluate the new devices which are introduced to the dentistry in the process of digitalization from giving the appointment to the patient till completion of the treatment. ***Methods***: Google, Pubmed and other databases were electronically searched and augmented by hand searches. Articles evaluating digitalization in dentistry and digital equipment used in dentistry and their efficiency are picked out. Collected data is statistically analyzed. Advantages and disadvantages of digitalization in dentistry are assessed. ***Results***: Digitalization in dentistry has many advantages like time saving, accuracy and precision of the treatment has increased, painless treatment, more comfort for patient and doctor, better diagnosing aids are included. ***Conclusion***: Digitalization increases the quality of treatment. It is not easy to incorporate the digital equipment in present dentistry as it needs heavy investment. Coactions of dentists and dental team members can make dentistry digitalized.

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INTRODUCTION

Now-a-days every field is improving its capabilities by digitalization and dentistry is not an exception. Dentistry has been improved astonishingly when we compared the procedures performed three decades ago or even a decade ago. The progress in dentistry shows clearly that the dentistry has experienced and enlivened amount of technological growth.[1] Although in comparison to other fields like automotive or aeronautics, medicine, biomedical engineering, electronics and others, dental profession is a bit late in improvement. In dentistry a variety of digital advancements such as holography, cone beam computed tomography(CBCT), laser scanners, software for computed-assisted design/computer –assisted manufacturing(CAD/CAM), intraoral and face scanners and 3D printing provide new possible substitutes to replace the physical work and improve the quality of care and patient experiences.[2] The digitalization has several superiorities including dental procedures with greater precision, time saving, comfort for patient as well as doctor,[3] making detail records, providing information exchange with different centers for planning treatments, clearly show patients the condition of their mouth and efficiency than ever before.

There are 4basic stages in the work of modern digital dentistry i.e; 1. Image acquisition 2. Data preparation/processing 3. The production 4. Clinical application on patients.

Patient consulting doctor: In modern dentistry patients consults the doctor through apps. These apps provide a video chat by which doctor can assess the basic problem of the patient. So that they can reduce unnecessary visiting to the dental hospitals or a doctor can suggest precautionary measures or medications for controlling spread of the disease until patient comes to the clinic. List of some apps related to dentistry 'Med sage', 'heal con practice', DDS GD, CDT code check, lexi-dental complete, iRomexis, my dentist, dental manager, I dental care. But in India usage of these apps is very limited, a complete awareness to the people is required. To ensure that the patients come for their regular checkups at proper time of given appointment the doctors can send remainder messages to the patients through these apps.

Patient record management: In previous days, appointments are given and recorded in scheduling books manually. But now various computer-based software for the dental offices have evolved not only to make appointments, but also patient's detailed case history can be recorded as well.[1][4]

By this digitalized patient records dentists today are making it easier for patients to make and keep their dental hygiene and treatment appointments via the web. On top of that, communication programs make it easier for dental doctor to clearly share the case history about patients' case with their lab technicians and specialists to ensure proper care and reduce the number of patients office visits. Health care organizations maintain medical records for several key purposes like patient care, communication, legal documentation, billing and reimbursement research and quality management.

Cone beam Computed Tomography: Cone Beam CT is not similar to conventional CT. Dental cone beam computed tomography is a peculiar type of x-ray appliances used when regular dental or facial x-rays are not sufficient. It is not used frequently because the radiation exposure from this scanner is significantly more than regular dental x-rays.[5] This dental CBCT provides a quick 3D image of patients oral or maxillofacial anatomy.[6] It gives a detailed image, which can be viewed in 360 degrees accurate to $1/10^{th}$ of minimum. It plays a key role in implant placement for oral surgeons and Periodontists. It enables to place implants with greater accuracy and also to identify TMJ problems.[1] We can explore gums, teeth, vital areas like sinuses and can also measure the thickness of the bone and orientation of nerves with the help of dental CBCT.

Digital Imaging: Radiographs play a key role in proper diagnosis and treatment planning. Traditional radiographs contain radiographic films which are processed by lab technicians in several steps but now-a-days digital radiography is emerging by which we can capture data using a sensor for immediate viewing with less exposure time.[7] The image produced by digital radiography can be shared to specialists through emails. Digital radiographs produce a clear image even though exposure time is less because of the more sensitive sensors. The image produced by digital radiography can be zoomed for proper diagnosis and also stored for further reference. There are 256 shades of grey in digital radiograph which are less in conventional radiograph. Digital radiography helps in reducing the usage of processing solution and bar film packets, which contain lead. This shows good impact on environment.[1]

Intraoral scanners: Making impressions of oral cavity of the patients is the starting step of most of the dental treatments. The accuracy of impressions is key feature for success of the treatment.[8][9] Earlier impressions were made using conventional trays and elastomeric impression materials. In digitalized dentistry these trays were replaced by intraoral scanners. Intraoral scanners were used in digital dentistry for making digital oral impressions of the patients' oral cavity. Intraoral scanners work on the basis of 3D capturing technology which converts 2Dimages into 3D images and shows it digitally.[10] Advantages of intraoral scanners over traditional impression making are time saving, thus more patients can be attended to, high accuracy of impression, saves money or impression material cost, patient comfort is increased.

Optical scanners: Shade matching is very important in prosthetic dentistry because it is related to esthetics. It plays even more crucial role in maxillofacial prosthesis. Thus, an accurate determination of tooth color is important for giving out a definitive result. There are many difficulties arising in dental aesthetic restorations regarding shade matching. Shade guide is used for color matching of dental restorative materials with the tooth, while restoring the tooth dental clinic. Shade guide is a standard model consisting of several shade tabs. Accuracy of visual color determination has been on 40-60%. To solve this problem, electronic shade matching equipment came into existence. They are widespread in dentistry. Spectrometers and calorimeters are most commonly used devices. But complete information regarding tooth color cannot be obtained because these devices do not provide image information.[11]

Diagnodent: Diagnodent is a tool designed for early detection of caries. It is very effective in diagnosing even smallest lesion early stage. It detects the caries by measuring the increased light induced fluorescence.[1][12] Conventional methods like visual examination with dental explorer and x-rays show us decay on surfaces of the teeth, advanced decay, and decay between the teeth. But these methods failed to detect the decay hats located inside the tooth.[13] This diagnodent is placed on the teeth and gives dentists a digital readout, which can help to detect the decay inside the teeth. This recent technology uses sound, pulse and laser to detect caries. With this technology we can more accurately detect the decay in earlier stages before the decay spreads and damage whole tooth.

3D printing: Three-dimensional (3D) printing technology is an advanced technology to create personalized 3D objects automatically based on computer aided design digital models.[14] Nearly from 3 decades this 3D printing has been used in different fields like industry, design, engineering and manufacturing. This 3D printing technique has applications in dentistry. Almost all the branches like Prosthodontics, Oral and maxillofacial surgery, Endodontics, Periodontology, Oral Implantology to Orthodontics.[14] The restorations which are produced by 3D printing are more accurate and faster when compared to the restoration created manually. Selective laser melting, digital light processing stereolithography, fuse deposition modeling are the other 3D printing technologies used in dentistry. As 3D printing has many uses and its accuracy, fastness case of fabrication, it will become widely used method in dentistry.[15][16][17]

The WAND: "The WAND" is a computer-based tool which helps the dentist in delivering local anesthesia at the location of dental operation. WAND can deliver anesthesia in a slow and orderly manner, which makes injection painless.[1] As it is painless, it is an excellent alternative to treat the children.[18][19][20] As it is computer assisted tool it delivers exact amount of local anesthesia with controlled pressure. So that it reduces unnecessary sensitivity that patient feels when they have anesthetic injection. WAND can numb up to one single tooth on which the dental procedure is carried so that patient do not have to walk out with fat tongue and lips.[1] It looks like a pen. So that there is no anxiety created among patients and easy to handle for dentist.

Diode Laser: Dental lasers are introduced in mid-1990's. among other dental lasers diode lasers became more popular because of their applications in dentistry.[21][22][23] Diode lasers are predominantly used in soft tissue surgeries in oral cavity such as biopsy, frenectomy, implantology, soft tissue gingivectomy.[1] Near infrared wavelength lasers are ideal for surgical procedures of oral soft tissue due to their high absorption in hemoglobin. NIR lasers are gold standard for

excision or vaporize the target site as they have better cutting efficiency, coagulation and precision. These diode lasers are at low cost and small, portable, cordless units are also made by manufacturers. This makes them desirable in the dental practice.

Advantages

- Patient satisfaction is more.
- Long life of restorations and esthetics improved.
- Accuracy and precision improved.
- Less time for treatment.
- Disadvantages
- Cost of the equipment used is high, it needs a heavy investment.
- Main limitation for dentists is to explore about new procedures and get trained.

MATERIALS AND METHODOLOGY

This study is based on searches from Google, Pubmed, and other databases available on internet. This data is electronically searched and augmented by hand searches. The search includes keywords such as digital dentistry, CBCT in dentistry, patient record management, diagnodent etc. Articles evaluating digitalization in dentistry and digital equipment used in dentistry and their efficiency are picked and this collected data is statistically analyzed(Table:1). Based on the search results the advantages and disadvantages of digitalization in dentistry are assessed.

RESULTS

101 articles were found by electronic search by keyword (Pubmed, Medline, Embase). The line diagram which gives the information about the number of articles published in each year from past 10 years related to digital dentistry (FIG 1). From the line diagram, we can conclude that the number of articles published were more in the past six years. The highest number of articles published on digital dentistry, record management, CBCT in dentistry, diagnodent are in the years 2020,2022,2019,2021 respectively. There are total of 28 searches for digital dentistry, 30 searches for record management and CBCT in dentistry, 13 searches for Diagnodent. Still researches, surveys are going on about digitalization in dentistry.

DISCUSSION

This study is done originally to evaluate the recent advances which are introduced in to the dentistry in process of digitalization. Digitalization is not a new term and can be seen in form of CBCT, intra oral sensors, CAD-CAM, lasers etc., seemingly digitalization is a bit late in to the dentistry than any other fields. But still there is scope for further development. India is a bit behind in digitalization compared to the developed and developing countries. This can be related to as lack of awareness about the recent advances in digital dentistry and also the high installation and maintenance of these highly sensitive and sensible devices. In India, most of the digitalization can be seen only among the big cities and large dental chains.

Table 1.

Reference articles	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Digital dentistry	0	1	0	2	2	3	2	8	4	6	0
Record management	1	0	0	1	2	5	3	6	4	7	1
Cbct in dentistry	3	2	1	2	1	6	7	3	2	3	0
Diagnodent	2	1	1	2	1	0	1	0	5	0	0

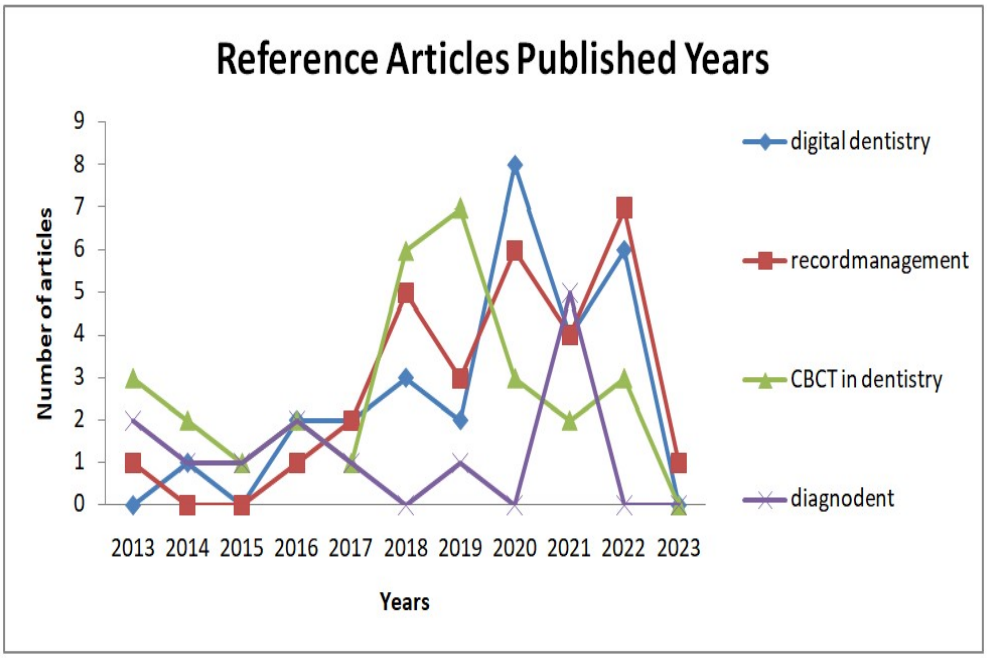

Figure: 1

Despite of many advantages like precision of treatment, accuracy and time saving, high treatment cost and lack of awareness of advantages make these digital devices less prevalent. Although the diagnosis and treatment become comfortable for both patient and doctor there are many challenges to overcome. Some of disadvantages include high cost of treatment, lack of awareness among some of practitioners and patients and also these technologies require frequent updates and upgrades. These could easily be exceeded by newer technologies as there is never an end for new inventions.[24] Also results of some of the devices are not so accurate but still have proven to be advantageous over the manual and conventional procedures. Hence despite some disadvantages, good knowledge and cooperation among the fellow dentists and dental team and good knowledge in maintenance of these devices not only increases the accuracy of the treatment but also helps with a painless and hassle-free treatment to those in dire need.

CONCLUSION

Digitalization refers to use of digital or computer-controlled components to carryout dental procedures instead of using mechanical or electrical tools. Like any others digitalization has many advantages as well as many disadvantages while incorporating the system. The successful incorporation of digitalization in dentistry depends upon the knowledge of dentist as well as entire dental team. This digitalization has many advantages at the same time it has few disadvantages which can be overcome by little hard work and team work.

GLOSSORY OF ABBREVATION

CAD/CAM: Computed-assisted design/Computer –assisted manufacturing

CBCT: Cone beam computed tomography

CDT code check: Current dental terminology

TMJ: Temporomandibular joint

NIR: Near Infrared

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