



The Application of Digital Diagnostic Aids in the Early Detection of Dental Caries

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ABSTRACT

The utilization of digital diagnostic aids has introduced novel prospects in the timely identification of dental caries, enhancing the caliber of dental healthcare, diminishing expenses associated with long-term treatment, and, notably, ameliorating dental well-being and patient quality of life. The objective of this study is to investigate the utilization of digital diagnostic aids in the early identification of dental caries. The literature search procedure was conducted across multiple databases, including PubMed, Web of Sciences, EMBASE, Cochrane Libraries, and Google Scholar, to explore the application of digital diagnostic aids in the early identification of dental caries. The utilization of digital diagnostic aids enables dental professionals to deliver comprehensive, efficient, and prompt healthcare services to individuals, thereby enhancing dental well-being and overall quality of life. Additionally, this approach helps mitigate the expenses associated with extensive treatment that may become necessary if dental caries is identified at a later stage. The advent of digital technology has significantly enhanced the prospects of a more promising future in the field of dentistry, with a heightened emphasis on preventive measures and timely intervention.

1. Introduction

Dental health is an important aspect of maintaining a person's general well-being. One of the common problems often encountered in dental care is dental caries, which usually develops without obvious symptoms in the early stages. Dental caries can cause pain, significant tooth damage, and even tooth loss if not detected and treated early. Therefore, early detection of dental caries is crucial to prevent more serious damage and higher treatment costs in the future. In the digital era that continues to develop, innovation in the world of dentistry is also increasingly advanced. One prominent development is the use of digital diagnostic aids in early detection of dental caries. This technology has changed the diagnostic paradigm of dentistry, providing an advantage in

detecting dental problems at an early stage before more serious damage occurs.^{1,2}

Utilization of digital diagnostic aids, such as digital radiography, 3D imaging, and advanced image processing algorithms, has enabled dental professionals to identify dental caries more accurately and efficiently. This tool allows the detection of dental caries even before symptoms such as pain or visual changes visible to the human eye appear. The use of digital diagnostic aids has opened up new opportunities in early detection of dental caries, improving the quality of dental care, reducing long-term care costs, and, most importantly, improving dental health and patient quality of life.^{3,4} This study aimed to explore the use of digital diagnostic aids for early detection of dental caries.

2. Methods

The literature search process was carried out on various databases (PubMed, Web of Sciences, EMBASE, Cochrane Libraries, and Google Scholar) regarding the utilization of digital diagnostic aids for early detection of dental caries. The search was performed using the terms: (1) "benefits" OR "diagnostic" OR "digital" OR "early detection" AND (2) "dental caries" OR "dental health." The literature is limited to clinical studies and published in English. The literature selection criteria are articles published in the form of original articles, an experimental study

about the utilization of digital diagnostic aids for early detection of dental caries, studies were conducted in a timeframe from 2013-2023, and the main outcome was the utilization of digital diagnostic aids for early detection of dental caries. Meanwhile, the exclusion criteria of the study were not related to the utilization of digital diagnostic aids for early detection of dental caries and duplication of publications. This study follows the preferred reporting items for systematic reviews and meta-analysis (PRISMA) recommendations.

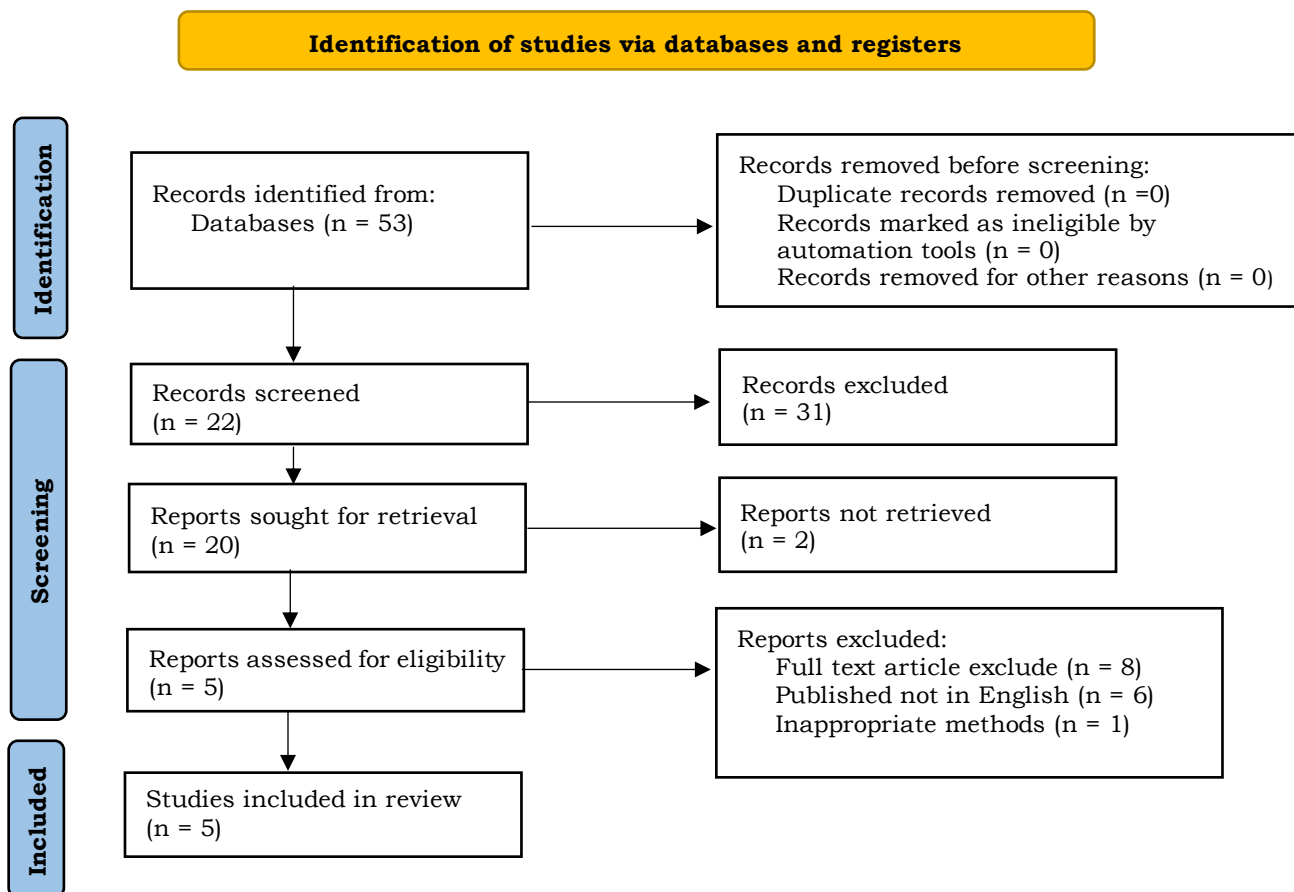


Figure 1. PRISMA flowchart.

3. Results and Discussion

Accurate early detection

Digital diagnostic aids utilize advanced technologies, such as digital radiography and 3D imaging, to reveal dental caries even in the early stages

of its development. Digital diagnostic aids enables the detection of dental caries at an early stage of its development, even before symptoms of pain or visual changes appear. This allows for earlier and simpler treatment, which in turn can avoid more serious

damage to the teeth. By detecting dental caries at an early stage, the risk of complications such as tooth root infection or significant structural damage can be minimized. This prevents patients from experiencing severe pain and more invasive treatments. Dental caries that are detected at an early stage tend to require simpler and cheaper treatment than caries that have already significantly damaged the teeth. This can reduce long-term care costs for patients.⁵⁻⁷

Examinations using digital technology are often faster and more convenient for patients because they reduce the need for images or lengthy diagnostic procedures. Digital diagnostic aids create an accurate digital record of the condition of a patient's teeth. This is beneficial for long-term monitoring and proper treatment planning. The use of advanced technology in dental caries diagnostics illustrates how innovation can provide real benefits in the world of dentistry. With the ability to detect dental problems at an early stage, practitioners can provide more preventive and effective care, improve the quality of patient dental care, and overall advance the field of dentistry.⁸⁻¹⁰

Progress monitoring

The use of digital technology in recording images and data presents a number of important benefits in monitoring the development of dental caries and making more informed decisions in the long-term care of patients. With digital technology, dentists can produce sharper and more detailed images and data from the patient's dental caries. This allows them to more accurately monitor caries progression over time. Doctors can easily compare previous images and data with the latest to see whether caries have progressed or stabilized. More accurate data and careful monitoring allow dentists to plan more appropriate treatment. They can determine whether caries need to be treated, filled, or monitored periodically. This leads to more personalized and effective care according to each patient's condition.^{11,12}

With careful monitoring, dentists can take early action if dental caries begin to develop. This avoids greater damage to the teeth and prevents tooth loss that may occur if caries are left unattended. Careful monitoring allows for more timely treatment. Caries

that are identified and treated at an early stage require simpler and less expensive procedures compared to treatment given when the caries have reached a more severe level. Digital data creates complete and accurate patient records. This is beneficial for long-term monitoring and ensures that patients receive treatment that is consistent and appropriate to the progression of their dental caries. The use of digital technology in monitoring the development of dental caries helps dentists provide more careful, effective, and timely treatment to patients. This supports the principles of prevention and better dental care, which in turn improves patients' dental health and reduces the risk of long-term complications.^{13,14}

Reduction of radiation exposure

Digital radiography produces a lower radiation dose compared to conventional radiography. This means that patients and medical staff involved in taking radiographic images will experience lower radiation exposure. This is very important, especially in long-term monitoring and if the patient requires repeated imaging. Digital radiography helps create a safer environment for patients. This is important because excessive radiation exposure can increase the risk of cancer and other health problems. With lower radiation doses, patients do not need to worry about the risk of overexposure when undergoing radiographic testing. Digital radiography is often quicker and more convenient for the patient. The image-taking process can be done more quickly, and patients do not have to wait long or experience discomfort during the radiography procedure. Digital radiography data can be easily stored in the form of an electronic file and can be quickly shared with colleagues or other specialists if needed for consultation. This improves efficiency and coordination of care. Digital radiography also has a lower environmental impact. By reducing radiation doses and the use of processing chemicals, digital radiography helps reduce hazardous waste and the use of resources required for processing radiographic films. With these benefits, digital radiography has become the standard in many dental practices. This not only makes the diagnostic process safer and more

comfortable but also helps maintain the health of patients and medical staff involved in dental care.^{15,16}

Better image quality

The clarity of the images produced by digital technology is a major advantage that helps dentists better identify dental caries. In difficult cases or when the dental caries are located in a hard-to-reach area, sharper images allow the dentist to better identify the caries. This includes areas between teeth, small cracks, or hidden caries. With clearer images, dentists can detect dental caries at a very early stage, even before they reach the tooth surface. This is the key to prevention and simpler treatment. Sometimes, changes in the teeth can be similar to dental caries, such as mineral spots. Clearer images help the dentist differentiate caries from spots or other anomalies so that appropriate treatment can be decided. With sharper images, dentists can clearly see the damage caused by caries and plan the most appropriate treatment according to the level of damage and location of the tooth caries. Sharp images also allow dentists to provide better explanations to patients regarding the condition of their dental caries. Patients will better understand their problem and the potential treatment needed. Image clarity in digital technology creates a strong basis for early detection of dental caries and more informed treatment decisions. This helps reduce the risk of more serious tooth decay, improves the quality of dental care, and ensures that patients receive treatment that suits their needs.^{17,18}

Practice efficiency

Digital Diagnostic Aids not only provide benefits in the diagnosis of dental caries but also in improving the overall efficiency of dental practice. The use of digital technology in taking radiographic images and 3D imaging is often faster than conventional methods. This saves dentists and medical staff time in the diagnosis process. Patients also don't have to wait long for image results. Images and data generated by digital diagnostic aids can be immediately available in digital format. This eliminates the need for the film-developing process as in conventional radiography, which requires additional time. Patient data, including

radiographic images, can be easily stored in digital form. This reduces the need for physical storage and makes it easier to search and access patient data.¹⁹

Digital data can be easily shared with specialists or peers in an easy-to-understand format. This allows for better collaboration in patient care. Digital Diagnostic Aids can reduce errors associated with image and data processing. This helps ensure that the data generated is accurate and reliable. By reducing the time required for administrative tasks such as image processing, medical and dental staff can focus more on patient care. This improves patient experience and quality of care. Digital technology often includes features that enable dental practices to better comply with patient data security regulations and standards. This increased efficiency not only benefits the dental practice internally but also the patients. A more efficient practice can reduce patient wait times, provide faster results, and improve the overall quality of dental care.²⁰

4. Conclusion

By using digital diagnostic aids, dental practitioners can provide more thorough, effective, and timely care to patients, improving dental health and quality of life for patients, as well as reducing the costs of long-term treatment that may be required if dental caries is detected too late. Digital technology has opened the door to a brighter future in dentistry, where prevention and timely treatment are top priorities.

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