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Impact Of Digital Dentistry On Quality Of Life In Relation To Oral Health

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Abstract

Dentistry is a part of the field of medicine that is being promoted in this digital revolution. The increasing trend in digitalization of dentistry has led to advances in computer-generated data processing and manufacturing. Digitalization has gradually taken root in dentistry, starting with computed tomography in the 1970s. [1]The most disruptive events in digital dentistry have been the introduction of digital workflows and computer-aided manufacturing, which have made new procedures and materials available for use in dentistry. In addition, many other less disruptive but relevant innovative approaches have been developed in digital dentistry. They will or are already having an impact on prevention, diagnosis and treatment, and thus on patients' oral health and, consequently, on their oral health-related quality of life. Both software and hardware approaches attempt to maintain, restore or improve a patient's oral health. This article highlights innovations in dentistry and their potential impact on patients' oral health-related quality of life in prevention and treatment. Furthermore, potential future developments and their possible implications are described.

Keywords: *Digitalization, Dentistry, Digital Dentistry, Oral Health-Related Quality of Life.*

Introduction

The era of digital dentistry has become a reality. Although traditional dentistry provides effective preventive and therapeutic options to maintain, improve or restore patients' quality of life related to oral health, digital dentistry offers additional tools to achieve this goal [1]. It also contributes to making accurate patient diagnosis by dentists and making critical decisions in therapeutic intervention, which makes the treatment process more convenient for patients [1,2]. Modern digital applications in dentistry also contribute to reducing human error, increasing accuracy and saving time, in stark contrast to traditional dentistry [3]. For example, artificial intelligence in dentistry can help dentists detect and diagnose dental diseases, such as tooth decay, gingivitis and oral cancer, using advanced image analysis and machine learning algorithms [4,5]. Digital applications in dentistry can also help in planning and performing dental procedures, such as implant placement, root canal treatment and orthodontic treatment, using computer-aided design and manufacturing (CAD/CAM) and robotic systems [6].

The effects of digitalization in dentistry have many positive effects on the development of dentistry and oral health [7]. Therefore, this paper will focus on the expected benefits of

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digitalization as perceived by patients on patients' oral health-related quality of life, and will provide an overview of current imaging tools, software and manufacturing equipment with clinical examples in a multidisciplinary setting.
This paper will evaluate the impact of digital transformation processes in dentistry, covering different medical specialties. Finally, we will review new developments in digital dentistry that may impact on the quality of life of patients in the healthcare field.

Oral Health-Related Quality of Life

Good oral health ensures a higher quality of life and better dental maintenance .Oral health-related quality of life is defined as a multidimensional concept that reflects people's satisfaction with eating, sleeping, and social interactions, as well as their self-assessment, satisfaction, and expectations about their oral health status [8]. The concept of oral health-related quality of life is based on functional (chewing and speaking), psychological (appearance and self-esteem), social (relationships and social communication), and pain and discomfort (acute and chronic) aspects [9]. Also, describes the impact of diseases and conditions of the mouth and face, as well as the impact of advanced treatments for these conditions [9,10].
Considerable effort has been invested in developing tools to measure oral health-related quality of life (OHRQoL). In addition, opportunities have opened up to study how oral health affects aspects of social life [11,12]. Researchers have begun to suggest the relationship between oral health and health-related quality of life (HRQoL), and to understand the interactions between traditional clinical variables (such as diagnosis), clinical examination data, and self-reported, person-centered health experiences [9,13]. Self-ratings of oral health quality of life reflect individuals' comfort with eating, sleeping, and social interactions, as well as their self-esteem and satisfaction with their oral health. With increasing focus on health policy to address health promotion and disease prevention, health-related quality of life and workplace health-related quality of life have come to include both positive and negative perceptions of oral health and health outcomes [14]. Thus, assessments of oral health can reflect both negative effects and self-enhancement and well-being. For example, people may seek dental care for preventive treatment (e.g., cleaning) or elective treatment (e.g., orthodontics) [9]. Health psychologists have recognized that psychological assets such as optimism and resilience are related to an individual's quality of life, particularly their ability to cope with illness and ill health [15].

Innovations in Digital Dentistry

Digital dentistry dates to the 1970s. Since then, digital technologies have had a major impact on dentistry [16]. It began as an idea to make dental restorations from ceramic instead of metal and has evolved into an entirely new industry over the past few decades. There have been dramatic changes, such as the introduction of computer-aided design/computer-aided manufacturing (CAD/CAM) intraoral scanners that provide high-resolution digital impressions, reducing patient discomfort and improving accuracy compared to traditional methods, which has caused dramatic changes in the materials available, and therefore dentists' preferences [6,17]. However, there are also many more subtle changes in dentistry, from the introduction of software and other medical imaging tools to manufacturing devices. Additionally, 3D printing is transforming the production of models, surgical guides, and prosthetics, allowing for custom solutions tailored to individual patient needs [18,19]. The integration of these digital tools not only enhances clinical outcomes, but also dramatically improves patient experience and satisfaction. As digital dentistry continues to evolve, its impact on oral health-related quality of life has become increasingly apparent, highlighting the importance of embracing these innovations in contemporary dental practice [20]. Many of these changes will impact workflow, communication between practitioners and patients, material selection, and clinical outcomes. Most digital technologies begin as standalone solutions but will soon be implemented into more comprehensive digital networks [21]. These changes include the

speed and quality of communications, reduced time required for technical or clinical procedures, improved quality and predictability of outcomes, and patient comfort [19,20].

Limitation of Digital Dentistry

Digital dentistry offers many benefits, but the potential limitations and challenges associated with its implementation must be acknowledged [3]. One limitation is the initial cost of adopting digital technologies, which can be prohibitive for some dental practices. Additionally, the learning curve associated with mastering new digital tools and technologies may require additional training and time for dentists and dental staff [17]. Furthermore, concerns about data security and privacy must be addressed to ensure that patient information is protected in digital systems. Another limitation is the reliance on technology, as technical glitches or system failures can disrupt dental workflow and potentially compromise patient care. Furthermore, not all dental procedures can be completely replaced by digital technologies, and traditional approaches may still be needed in certain situations [22]. Recognizing these limitations along with the benefits and positives, and working to address potential concerns, can provide a more balanced and comprehensive perspective on digital dentistry.

Digitization in Prevention and Diagnosis

Digitization in dentistry plays a crucial role in disease prevention and early diagnosis. The World Health Organization defines prevention as activities aimed at reducing the likelihood of disease occurrence or progression [23]. Intraoral scanners (IOS) facilitate full-arch scans during routine check-ups, allowing dentists to superimpose current data over previous scans. This enables the early detection of issues such as gingival recession, tooth wear, and movement before they become clinically visible [24]. Advanced software like OraCheck and Trios Patient Monitoring enhances this process by predicting tooth wear rates and providing individualized patient assessments. Furthermore, IOS technologies can reveal plaque accumulation, assisting in oral hygiene education. In pediatric dentistry, digital impressions offer a more comfortable experience for children, promoting better cooperation and reducing the anxiety often associated with traditional methods [25]. Devices like DIAGNOcam and near-infrared light technologies enable radiation-free caries detection, minimizing exposure while ensuring early diagnosis [26].

Telemedicine and mobile applications also enhance preventive care, facilitating remote consultations and promoting oral health habits [27]. Overall, these digital innovations not only improve diagnostic accuracy but also help maintain patients' oral health-related quality of life by preventing unnecessary treatments and minimizing dental visits. However, it’s essential to navigate potential risks, including the pressure for aesthetic perfection, which can lead to unnecessary procedures and negative health outcomes [27,28].

Patient Education and Diagnosis

In addition to its prevention and treatment benefits, digital dentistry also provides better patient education and communication. Dental professionals can communicate with patients more easily and effectively by using digital imaging and planning tools to visualize their dental condition. Compared to traditional dentistry, digital dentistry has several benefits. Higher accuracy, shorter treatment times, greater patient comfort, and more effective teamwork and communication [29]. Additionally, digital dentistry has the potential to reduce the environmental impact of dental care by reducing waste, energy use, chemical use, transportation emissions, and paper use [30]. Dental practices can take steps toward improving environmental sustainability by implementing digital dentistry technology. By improving patient outcomes, enhancing efficiency, improving communication and patient happiness, encouraging teamwork among dentists, and improving record keeping, digital dentistry can help both private practices and dental hospitals [29,30].

Future Benefits of Digitization in Dentistry

Looking ahead, numerous additional benefits can emerge from advancements in dental technologies. Optical coherence tomography, for example, enables detailed evaluation of composite and ceramic restorations, enhancing diagnostic capabilities. Future software may facilitate the diagnosis of conditions like temporomandibular disorders, providing evidence-based support for treatment decisions [31].

In time, intraoral scanners (IOS) may evolve to replace manual evaluations of teeth, plaque, and pockets, shifting the focus from simply replacing traditional impressions to maximizing the added benefits of IOS [24]. Current models already offer comparable precision and accuracy with greater patient comfort. The future promises a new realm of dentistry centered around simulation, predictability, and prevention, crucial for maintaining optimal oral health-related quality of life (OHRQoL). Innovative technologies, such as dedicated dental magnetic resonance imaging, present new, radiation-free diagnostic possibilities [21]. While hard tissues can be routinely replaced, the prospect of 3D printing for soft tissues could revolutionize treatment options. However, challenges remain, including the accurate representation of movable oral mucosa for removable prosthodontics [32].

As these advancements unfold, it is vital to balance innovation with cost and patient burden. Traditional methods should remain in practice until the advantages of digital dentistry are proven to outweigh associated risks and costs. Establishing a standard metric to measure these impacts will be essential for guiding future developments in oral health care.

Conclusions

Modern oral healthcare delivery should be based on digital transformation, which has proven to be effective in terms of patient quality of life benefits. Digitalization in dentistry will facilitate oral healthcare to an optimal level. It will indefinitely reduce unnecessary contact between patients and healthcare providers, shorten treatment duration, and be more cost-effective in the long run. Research in the field of digitalization in healthcare and especially in dentistry should be the main focus in the next few decades with the aim of improving data acquisition and large data sets, safety and security of “big data”, modernization of neural networks, machine and deep learning for artificial intelligence, and other related areas.

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