

Digitization of Dental Services



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Abstract

Technology has taken over so many aspects of the world, especially in medicine. Dentistry is no exception. The transition to digital dentistry has grown more and more and a number of digital devices used in dental offices already go unnoticed but incorporate very advanced digital technology. The most common and frequently used form of dental dentistry is digital x-rays. The benefit of this technology is not only a much smaller volume of X-rays compared to the classic technology, but they allow a better and early detection of cavities. The delivery of contemporary oral healthcare should be guided by cutting-edge technology focused on achieving patient-centred outcomes. The integration of digitalization into dentistry will enhance oral healthcare to its highest potential. The emphasis in forthcoming decades should lie on research endeavours pertaining to digitization within the healthcare domain, particularly within dentistry. The primary objective should be the enhancement of data acquisition methodologies and the management of large datasets, while concurrently addressing the safety and security concerns associated with "Big Data".

Keywords: digitization, augmented reality, virtual reality, tele-medicine, tele-dentistry

INTRODUCTION

Digital dentistry is a broad term that encompasses any dental technology that involves the use of computer-based components such as hardware devices and software solutions. The goal is to enable dental professionals to deliver treatment using computer-aided tools.

Digital dentistry refers to the integration of digital technologies and tools into various aspects of dental practice, including diagnosis, treatment planning, treatment execution, and practice management. It encompasses the use of advanced digital devices, software, and techniques to improve efficiency, accuracy, patient outcomes, and overall dental care [1-5].

Areas of use of digital technology in dentistry



Figure 1. Types of digital dentistry

Digital imaging. Digital imaging technologies such as intraoral cameras and cone beam computed tomography (CBCT) provide high-resolution 3D images of the oral cavity. This helps in accurate diagnosis, treatment planning and communication with the patient. With digital dental X-rays, the image can be zoomed in, zoomed out, and the brightness, contrast, or sharpness can be edited to better detect cavities as early as possible. The actual digital sensor is also much more comfortable inside the mouth than regular films [6,7].

Intra-oral scanning. The scanner is a new tool that helps detect the smallest and earliest cavities. These devices can provide 90% accuracy in detecting occlusal cavities on the upper surfaces of teeth that even a dental explorer cannot detect. They can detect with about 80% accuracy the interproximal cavities found between the teeth. Based on the reading from the device, the dentist will have a better knowledge of how advanced the cavity is and can provide you with the appropriate treatment plan, whether it is a filling, an inlay or onlay, or a crown [8,9].

3D scanning of the mouth not only helps in the creation of dentures by sending the information directly to the laboratories electronically, but also allows the dentist to provide the best treatment better and more accurately [10-13].

Dental CAD/CAM machines enable same-day crown fabrication in the office. This is a huge convenience for you as the patient to not have to come back for a second visit.

Digital impression systems replace traditional putty impressions with intraoral scanners, capturing precise digital models of teeth and soft tissues. This eliminates the need for uncomfortable impressions and improves the accuracy of various restorative and orthodontic procedures. Choosing the exact shade of the prosthetic restoration fa

Not only can digital dentistry scan and create dentures, but there are also scanners to choose the perfect shade for dentures. Increased accuracy, speed and convenience make these improvements increasingly popular in dental practices.

Computer-aided design and computer-aided manufacturing (CAD/CAM): CAD/CAM technology allows the creation of digital impressions, the design of dental restorations (e.g., crowns, bridges, veneers) and their fabrication using milling or 3D printing techniques. This simplifies the restoration process, reduces chairside time and allows for same-day restorations [15-17].

Augmented reality and virtual reality. These technologies provide virtual simulations and treatment planning tools that help both dental professionals and patients visualize expected treatment outcomes. This improves treatment planning, patient education and shared decision making [12].

Surgery with guided implants. Digital tools such as 3D imaging, computer-guided implant planning, and surgical guides allow precise implant placement. This improves the accuracy, predictability, and success rates of dental implant procedures [16,17].

Tele-dentistry. Digital platforms and telecommunications technologies enable remote consultation, diagnosis, and monitoring of patients. Tele dentistry facilitates virtual appointments, provides oral health education, and enables case triage, expanding access to dental care in remote or underserved areas [18,19].

Education and training: Digital platforms offer online courses, webinars, and virtual training tools for dental professionals. This enables continuing education, improves skills, and keeps professionals up to date with the latest advances and techniques [20,21].

Management of digital cabinets. Digital technologies support practice management tasks, including electronic medical records (EDRs), appointment scheduling, billing, and inventory management. This improves efficiency, improves communication, and facilitates secure data storage and retrieval.

Adopting digital dentistry offers numerous benefits, including improved diagnostics, improved treatment planning, more accurate restorations, simplified workflows, improved patient experiences and efficient practice management. However, it is essential that dental professionals receive adequate training, ensure data security and privacy, and consider the cost-effectiveness of implementing digital technologies in their practices.

In the framework of this study, we aimed to highlight the use and openness for the digitalization of dental medical services in the Western area of Romania. At the same time, we tried to highlight the type of digital technology used in dental medical practice, to analyse the openness of patients from the western region of Romania to digitalization, the population's perception of the use of digital technology in the administration of dental offices, the population's perception the application of digital technology within dental treatments and in education the general population [23,24].

Table 1. The socio-demographic characteristics o the group

Variable	batch distribution	
Age	Avg Age = 47,4 yrs ± 11,3 yrs Minimum age = 19 yrs Maximum age = 69 yrs	
19 - 25 yrs	16	14,68%
26 - 35 yrs	25	22,93%
36 - 50 yrs	38	34,86%
51 - 60 yrs	21	19,27%
Over 61 yrs	9	8,26%
Male	51	46,68%
Female	58	53,32%
Urban	73	66,97%
Rural	36	63,03%

MATERIAL AND METHODS

The method used was the retrospective observational study carried out between August 2023 and January 2024. The research was carried out in 10 medical offices. A total of 109 participants were selected, who completed a questionnaire regarding their perception related to the digitalization of dental services.

The socio-demographic characteristics of the groups are similar as can be seen in the adjacent table. The data obtained from completing the questionnaires and oral assessments were entered into a database in Microsoft Excel 365, where they were processed.

RESULTS

The first aspect taken into analysis was the patients' perception of medical imaging and digital radiographs. The data obtained from the study are summarized in the table 2.

Table 2. Digital imaging and digital radiography services

Digital imaging and digital radiography services						
Variable		Very bad/ Totally disagree	Bad / Disagree	Neutral	Good / Agree	Very good / Totally agree
General perception of digital imaging	Count	8	10	12	23	56
	%	7,34%	9,17%	11,01%	21,10%	51,38%
Digital technology has reduced the time to complete work	Count	3	5	8	21	72
	%	2,75%	4,59%	7,34%	19,27	66,06%
Digital technology has reduced the discomfort of labor.	Count	3	19	33	23	31
	%	2,75%	17,43%	30,28%	21,10%	28,44%

From the data presented above, it can be seen how a technology already implemented for a long time came to be known, accepted and at the same time appreciated by its beneficiaries. More than 85% of the respondents saw the advantage of the shorter time to perform the work and almost half 49.54% appreciate a decrease in the discomfort caused by taking a dental x-ray.

Regarding the use of digital technology in the management of health records, the perception of patients is shown in the following table. From the data analysis it can be concluded that patients are not very informed about the use of digitized technology in this field of dental medicine, 38.53% not being able to indicate a clear answer to this question. As a result, the results on questions about improving the accuracy of data, its accessibility, and the easy exchange of information with other health care providers were flawed.

The grouping of almost 85% of respondents around the option "Neither agree nor disagree" signifies a lack of information. This fact is even more evident in the last question regarding the EHR, where an absolute majority (84.4%) considered that information technology did not in any way facilitate the faster transfer of information to other health service providers.

Table 3. Electronic Health Records (HER)

Electronic Health Records (EHR)						
Variable		Totally disagree	Disagree	Neutral	Agree	Totally Agree
The use of EHR in dental practices	Count	19	23	42	17	8
	%	17,43%	21,10%	38,53%	15,60%	7,34%
HER improved data accuracy and accessibility	Count	12	25	52	15	5
	%	11,01%	22,93%	47,71%	13,76%	4,59%
HER facilitated the exchange of information with other health care providers	Count	71	21	15	1	1
	%	65,13%	19,27%	13,76%	0,92%	0,92%

Closely related to EHR, information technology can also be used in dental office management. Of the 109 participants in the study, 63 (57.8%) stated that digital technology is not used for the management of patients and dental practice in the practice they visited. But those 46 respondents who stated that they benefited from this facility recognized the benefits both in terms of the duration and efficiency of the appointments (76%) but also as a simplification of memorizing and recalling the calendar with appointments in the office (85%). - table 4.

Table 4. Dental practice management software

Dental practice management software						
Variable		NOT used/ Totally Disagree	I don't think it is use/ Disagree	I think they use / I don't care.	Use of Software / Agree	100% certain use/ Totally agree
The office uses patient management software (109 r.)	Count	42	21	11	9	26
	%	38,53%	19,27%	10,09%	8,26%	23,85%
Software increased efficiency and decreased time (46 answ)	Count	1	1	9	21	14
	%	2,17%	2,17%	19,57%	45,65%	30,43%
The reminders received increased the convenience of appointments (46 answers)	Count	0	0	7	11	28
	%	0%	0%	15,22%	23,91%	60,87%

Another relatively recently implemented technology in Romania is CAD/CAM, which involves the realization of the design of a prosthetic restoration as well as its actual manufacture using digital technology. Analysing the collected data, we can conclude that 47.71% of the respondents were not confronted with this innovative technology. However, of the 57 respondents who benefited from the technology, 65% highly appreciate the quality of the resulting works and another 25% consider them good. Only 10% of beneficiaries are undecided about the benefits offered. The data is also similar in the case of time gained by using these technologies, 78.95% appreciating a significant time saving. All data is centralized in the table 5.

Table 5. Using CAD/CAM technology

CAD/CAM technology						
Variable		Don't know/ don't answer	Disaccord	Neutral	Accord	Totally Agree
I benefited from CAD/CAM technology (109 respond.)	Count	52	11	9	23	14
	%	47,71%	10,09%	8,26%	21,10%	12,84%
CAD/CAM technology reduced working time (57 answ.)	Count	52	3	9	22	23
	%		5,26%	15,79%	38,60%	40,35%
CAD/CAM technology has increased quality (57 answ.)	Count	52	1	5	14	37
	%		1,75%	8,77%	24,56%	64,91%

Analysing the recorded data related to tele-dentistry, we can see a great familiarity of patients with this field, 89% affirming that at least once they have benefited from such services. The answers are polarized when the question tries to identify the extent to which tele-dentistry has improved the process of solving the problem, to which 50% of the respondents answered "No". Dissatisfaction was not due to poor patient-physician communication as 97% of study participants said it was at least as good as or better than direct communication in the office (see table 6).

Table 6. Using Tele- Dentistry

Tele-dentistry						
Variable		NO Appointment ----- Totally Disagree	One Appointment ----- Disagree	Two Appointments ----- Neutral	Three Appointments ----- Agree	Four ore more app. ----- Totally agree
Benefited from a remote consultation	Count	12	8	26	31	32
	%	11,01%	7,34%	23,85%	28,44%	29,35%
Tele-dentistry has improved access to dental care	Count	33	21	9	32	14
	%	30,28%	19,27%	8,26%	29,35%	12,84%
Tele-dentistry has improved doctor-patient communication	Count	1	2	31	43	32
	%	0,92%	1,84%	28,44%	39,45%	29,35%

The analysis of the degree of patient involvement and education using digital technology revealed a relatively even distribution of those who did not benefit from this (29.36%), those who were indifferent (29.36%) and those who used by her (41.28%). What is worth noting in this chapter is the fact that just over 28% of respondents admit that digital tools have increased their engagement in dental care, with 50% stating that these resources have not been of any use to them. The situation is slightly more positive regarding treatment options where 41% of respondents stated that they identified information regarding treatment plans.

Table 7. Digital technology used in patient engagement and education

Digital technology used in patient engagement and education						
Variable		Totally disagree	Disagree	Neutral	Agree	Totally agree
Access to online platforms or educational resources	Count	21	11	32	4	41
	%	19,27%	10,09%	29,36%	3,67%	37,61%
Increased the degree of involvement in oral hygiene	Count	32	22	23	17	14
	%	29,36%	20,18%	21,11%	15,61%	12,84%
The resources received helped identify treatment plans	Count	9	24	31	39	6
	%	8,26%	22,02%	28,44%	35,78%	5,50%

The general perception of the impact of digitization in the activity of dental practices is overwhelmingly positive, with almost 91% of respondents recognizing the positive aspects brought by information technology.

Table 8. Analysis of the overall impact of digitization

Analysis of the overall impact of digitization						
		totally unsatisfied	unsatisfied	Indifferent	Satisfied	Totally satisfied
The degree of satisfaction with the digitalization of dental services	Number	3	7	16	41	42
	%	2,75%	6,43%	14,68%	37,61%	38,53%

DISCUSSIONS

Digital platforms and telecommunications technologies enable remote consultation, diagnosis, and monitoring of patients. Tele dentistry facilitates virtual appointments, enables case triage, and enables access to dental care for underserved or remote populations. It also supports post-treatment follow-up and patient education [19, 24].

Digital practice management software automates administrative tasks, appointment scheduling, billing, and inventory management. It improves workflow efficiency, improves

patient communication, and provides data analytics for informed decision making and practice growth [25, 26].

Digital tools such as patient portals, educational websites and mobile apps improve patient engagement and education. These platforms provide access to oral health information, appointment reminders, treatment videos and interactive tools for self-assessment and oral hygiene instructions [26,27].

Advanced software enables digital treatment planning and simulation, allowing dental professionals to visualize and plan complex procedures in a virtual environment. This aids in precise implant placement, orthodontic treatment planning and smile design, improving treatment predictability and patient outcomes [27, 28].

Digital platforms provide opportunities for dental professionals to access online courses, webinars and virtual conferences for continuing education and professional development. This promotes lifelong learning, keeping dental professionals up to date with the latest advances and techniques in the field [29].

Digitizing dental services offers numerous benefits, including improved diagnostic accuracy, improved patient communication, increased treatment efficiency, and simplified practice management. However, it is important to ensure data security, respect for confidentiality and adequate training to maximize the benefits and mitigate potential challenges associated with digital technologies in dental care [30].

CONCLUSIONS

From the study we undertook it could be seen that overall, the perception is positive regarding digital dentistry and its impact on dental care. In the fields where the technologies have been implemented for a longer time, the level of knowledge about them is higher, which makes the trust of the beneficiaries higher.

Patients appreciated the efficiency and convenience offered by digital dentistry. They reported a reduction in office time using CAD/CAM technology and digital impression systems. Tele dentistry has been seen as a convenient option for remote consultations and follow-ups, especially for those in remote or underserved areas. Analyzing the data in conjunction with the locality where the respondents live, we can appreciate that tele-dentistry is especially appreciated by patients who do not have access or have difficult access to dental assistance.

It is worrying that online information resources are used to identify alternative treatment options rather than prevention and oral care.

There are areas of digital technology that are currently not being fully utilized or that patients do not identify as being used. Better promotion of them would increase the level of trust.

Overall, the study demonstrates a positive perception of digital dentistry among participants, highlighting its benefits in terms of efficiency, accuracy, patient engagement and practice management. It emphasizes the importance of continuing education and training to maximize the potential of digital technologies in dental practices. Effective implementation of digital dentistry can improve patient outcomes, enhance the patient experience, and streamline the delivery of dental care.

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