ORIGINAL RESEARCH PAPER

Dental Science

KNOWLEDGE AND APPLICATION OF DIGITAL DENTISTRY AMONG DENTISTS RESIDING IN RAJASTHAN STATE: A QUESTIONNAIRE BASED CROSS SECTIONAL STUDY

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ABSTRACT

Background: The integration of digital technologies in dentistry is transforming treatment quality, patient care, and satisfaction. Digital dentistry encompasses a broad spectrum of tools such as digital radiography, intraoral imaging, CAD/CAM, shade matching, digital smile design, dental photography, and electronic patient record management. These advancements are enhancing preventive and restorative care, offering benefits in quality, time efficiency, and cost reduction, making digital dentistry a growing trend in clinical practice. **Aim:** This study aimed to assess the knowledge and application of digital dentistry among dentists in Rajasthan through an online questionnaire survey. **Methodology:** A cross-sectional, questionnaire-based study was conducted from November 2023 to January 2024 among dentists with varying levels of specialization in Rajasthan. An online survey consisting of 22 questions evaluated the use of digital technology in diagnosing and treating dental diseases. Responses were collected via Google Forms and analyzed using SPSS software. **Results:** Of 210 responses, 76.7% were general dentists, with 37.6% male and 62.4% female participants. Over 81% believed digital dentistry enhanced treatment quality and patient experience. Digital tools were noted for providing greater marginal accuracy and improved crown fit. Additionally, 77% of dentists affirmed that digital dentistry yields more precise results than traditional methods. **Conclusion:** Dentists in Rajasthan demonstrate substantial knowledge of digital technologies, which likely encourages the adoption of advanced practices in their clinics, improving dental care quality and efficiency.

INTRODUCTION:

The introduction of digital dentistry into clinical settings has fundamentally transformed the way patients receive dental care. With the aid of modern technologies, traditional 2D X-rays have evolved into 3D imaging, and intraoral scanning (IOS) now replaces conventional impression-making materials. Artificial implant applications, machining centers, and 3D printing devices enable the creation of precise and aesthetically pleasing restorations in a shorter timeframe, enhancing patient experiences and treatment efficiency. [1]

Digital systems are now integrated across nearly all dental disciplines, from diagnosis to treatment completion. Patients can receive crowns, veneers, inlays, and onlays in a single visit, significantly improving convenience. In removable prosthodontics, digital workflows deliver results with the same level of precision as traditional methods. Tools such as CBCT and 3D printing have revolutionized surgical guidance, enhancing accuracy and treatment outcomes. For implant dentistry, preoperative CT scans provide detailed information on tissue quality and anatomical landmarks, enabling the creation of surgical guides for precise implant placement and optimal prosthetic function. [2]

In endodontics, advancements in surgical tools have improved the detection of obliterated canals, facilitated endodontic surgeries, and supported autotransplantation procedures. Orthodontics has similarly benefited from technological innovations, with the development of transparent aligners, personalized devices, and retainers, enhancing accuracy, stability, and treatment efficiency. In maxillofacial surgery, digital tools enable musculoskeletal reconstruction, surgical guidance, and the creation of customized implants, demonstrating their versatility and potential to improve patient outcomes. [3]

Despite these advancements, greater awareness and knowledge of digital dentistry techniques among practicing dentists remain essential. These technologies, embedded across dental specialties, significantly enhance accuracy and patient satisfaction.

In the era of big data and analytics, dental professionals may need to undertake computing courses to make informed decisions and fully utilize available data. This shift could necessitate a greater focus on technological software within dental education. However, there are challenges. Overreliance on technology may compromise students' interpersonal communication skills with patients, peers, and educators. Furthermore, students might not develop adequate manual skills required for traditional dental techniques, potentially impacting their competency. [4,5]

Additionally, disparities in socioeconomic conditions may hinder the adoption of new educational technologies, exacerbating inequalities. Digital tools' growing prominence underscores the importance of evaluating current knowledge and practices among dental professionals, particularly in regions like Rajasthan. Addressing these gaps can help establish a foundation for future research, enhance educational curricula, and improve clinical outcomes in this evolving field.

The purpose of this investigation was to assess the understanding and application of digital dentistry among dentists in Rajasthan, identify existing knowledge gaps, and provide insights for advancing education and practice in this critical domain.

MATERIALS AND METHODS:

The survey was conducted among 210 dentists in Rajasthan between November 2023 and January 2024. Participants represented diverse experience levels, specialties, and sectors within the state's healthcare system. To determine the sample size, the following parameters were applied: 80% statistical power, an alpha error of 0.05, an effect size of 0.7, and a degree of freedom of 5. Using the G*Power software (version 3.1.9.2, Heinrich Heine University, Düsseldorf), the required sample size was estimated to be 200. However, 210 participants were ultimately included in the study, using a convenient sampling method.

The survey utilized a structured, self-administered

questionnaire comprising 31 closed-ended questions assessing knowledge, attitudes, and awareness of digital dentistry. The questionnaire was distributed online through platforms such as WhatsApp, Telegram, Facebook, Instagram, and email. It consisted of two sections: the first collected demographic data (age and gender), while the second focused on digital dentistry-related knowledge, attitudes, and comprehension.

The reliability of the questionnaire was assessed using Cronbach's alpha, yielding a value of 0.751, indicating acceptable internal consistency. Participants were provided with an outline of the study and asked to provide informed consent before participating.

Data collection was conducted through a Google Form survey link shared with the selected participants. The collected responses were entered into Microsoft Excel 2016 for organization and analysis. Statistical analyses were performed using SPSS (version 28.0, IBM, Chicago, Illinois, USA), with a significance threshold set at a p-value of 0.05.

Inclusion Criteria
1. General dentists
2. Dentists from different specialties in dentistry
3. Dentists who filled out the form completely

Exclusion Criteria
1. Dentists who did not fill out the form completely
2. Non-dentists
3. Undergraduates were not included.

RESULTS:
The online survey was completed by 210 individuals in total. The 210 respondents' demographic information is shown in Table 1. Of the 210 individuals, 37.6% were men and 62.4% were women. More than 75% of the dentists had been working for less than five years, and over 75% of them worked in urban areas. More than 81% of dentists believe that digital dentistry has improved the quality of dental treatment and patient experience. Digital dentistry provides greater marginal accuracy and interproximal fit for crowns. 78.1% of the dentists recommend the use of CAD/CAM for digital impressions. 65.7% of dentists consider it kid-friendly, and 81% believe it will have significant use in dentistry in the future. More than 80% of the dentists are aware of CBCT. 65.2% of the dentists believe that 3D printed models enhance the ability of surgical procedures. More than 47% of the dentists use intraoral cameras for screening and 3D printing techniques. More than 70% of dentists believe that knowledge of digital dentistry should be included in the preclinical curriculum. More than 77% of dentists believe that digital dentistry provides more precise results than conventional dentistry, as shown in Table 2, 3 and 4. Table 5 shows the frequency of responses for the reasons for not using digital imaging, with 35.2% believe due to a lack of awareness and 32.4% due to a lack of ability. The multivariate linear regression analysis of knowledge regarding digital dentistry showed a significant difference ($p \leq 0.05$) with respect to gender and general dentist. Total practice showed a significant relationship with respect to gender and area of practice. ($p \leq 0.05$)

Tables:
Table 1 Shows The Descriptive Statistics.

| Variables	Number	Percentage
General Dentist		
Yes	161	76.7
No	49	23.3
Gender		
Male	79	37.6
Female	131	62.4
Experience		
Less than 5 years	161	76.7
More than 5 years	49	23.3
Area of practice		
Urban	159	75.7
Rural	51	24.3
Total	210	100
Specialization		
Endodontics	16	7.6
Prosthodontics	14	6.6
Oral Surgery	8	3.8
Pediatric Dentistry	9	4.3
Periodontics	1	0.5
Public Health Dentistry	3	1.4
Oral Medicine	1	0.5
Orthodontics	4	1.9
Oral Pathology	1	0.5

Table 2: Frequency Of Responses To Knowledge Regarding Digital Dentistry Among Study Population

Questions	Correct Response N (%)
Digital dentistry improves the quality of dental treatment and patient experience	174 (82.9)
Digital dentistry provides greater marginal accuracy and internal fit for crowns	188 (89.5)
Recommend use of CAD/CAM for digital impressions	164 (78.1)
CAD/CAM is used to fabricate	56 (26.7)
Digital system is kid-friendly	138 (65.7)
Digital radiography has the advantage of lower radiation dose	145 (69)
Digital dentistry plays an important role in future dentistry	170 (81)
Digital dentistry provides more precise results than conventional dentistry	162 (77.1)
Field that utilizes digital dentistry the most	86 (41)
Awareness about the use of CBCT	172 (81.9)
Promotion of self-directed learning through smartphone applications	44 (21)
Use of 3D printed models enhances the ability of surgical procedures	137 (65.2)
Implementation of digital dentistry in preclinical curriculum in dentistry	152 (72.4)
Digital dentistry is more convenient than conventional practice	64 (30.5)
Current perceived knowledge of digital dentistry	109 (51.9)
Awareness about procedural expenses of 3D printers surgical guide	123 (58.6)
Perceived attitude towards digital dentistry	151 (71.9)
Digital dentistry enables the storage of comprehensive patient datasets	20 (9.5)
Use of intraoral camera for screening - Yes	128 (61)
Use of CAD/CAM - Yes	109 (51.9)
Use of optical spray for impressions- Yes	80 (38.1)
Taught about CAD/CAM in institution- Yes	132 (62.9)
Use of 3D printers in clinical practice- Yes	100 (47.6)
Ever planned CAD/CAM crown for your practice	123 (58.6)
Adopted CAD/CAM fabrication led to a change in the number of staff. - Yes	31 (14.8)
Lack of awareness	74 (35.2)
Lack of ability	68 (32.4)
Others	68 (32.4)

Table 3: Multivariate linear regression analysis of knowledge and practice regarding Digital dentistry

Variables	Total knowledge			Total practice Practice		
	t	ß[95% CI]	P-Value	t	ß[95% CI]	P-Value
General Dentist						
Yes	2.896	-0.10[-0.24-0.35]	.001*	1.562	0.11[-0.07-0.61]	0.12
No						
Gender						
Male	-1.469	0.19[0.07-0.38]	.004*	0.754	0.05[-0.24-0.53]	0.01*
Female						
Experience						
Less than 5 years	1.296	0.08[-0.05-0.25]	0.196	-0.835	-0.05[-0.55-0.22]	0.45
More than 5 years						
Area of Practice						
Urban	1.284	0.08[0.04-0.28]	0.20	-0.505	-0.03[-0.47-0.28]	0.04*
Rural						

*Signifcance diference≤0.05
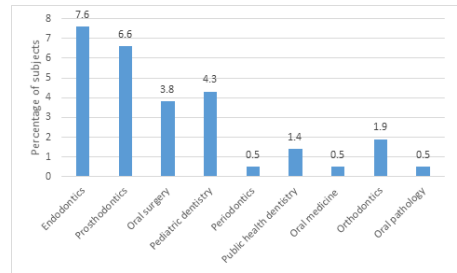
Graph 1 Shows Specialization Among Dental Professionals

DISCUSSION:

The impact of technological advancements on dentistry and oral healthcare has been profound. Three key areas have led this transformation: scanning technologies, practice/patient software administration systems, and computer-aided design/computer-aided manufacturing (CAD/CAM) technologies. Digital technology has advanced rapidly, revolutionizing dental information systems and workflows. Traditional impression techniques and their limitations regarding time, management, and materials are now largely avoidable with intraoral scans, which enhance productivity, precision, and patient care. The scope of technological systems today is vast, allowing for the digitization of various data types that can be easily collected, stored, and analyzed. [6]

Dentists are not aware of technological revolution reshaping the world. It is imperative for dental professionals to stay informed and knowledgeable about these contemporary trends. This study aimed to address the gap in literature regarding the understanding, awareness, and perspectives of Rajasthan-based dentists on digital dentistry. Comprehensive insights will help inform continuing education programs in this vital field.

In our study, 76.7% of participants were general practitioners—a higher percentage compared to the 42.3% reported in the study by Hall et al. [7]. Regarding gender, our sample comprised 62.4% females and 37.6% males, which aligns closely with Hall et al. [7], where females constituted 50.7% of the participants. In contrast, a study by Dhokar et al. [8] had a predominantly female sample (91.3%). Notably, 23.3% of specialists in our study were Endodontists, differing from the findings of Kakti et al. [9], where Prosthodontists were the majority.

The results of our study reveal that 82.9% of respondents believe digital dentistry enhances the quality of dental care and improves patient experiences. This finding is consistent with Al-Ibrahim et al. [10], where 89.3% of participants agreed that digital dentistry aids in better diagnosis and treatment outcomes. Furthermore, 78.1% of dentists in our study recommended CAD/CAM for digital impressions, aligning with Ramesh Nayakar et al. [11], who found a high familiarity with CAD/CAM technologies among participants.

However, these findings contrast with the Hall et al. study [7], which reported that 75.9% of respondents had a favorable opinion of practicing digital dentistry. In comparison, only 47.3% and 64.2% of participants in our study demonstrated intermediate levels of knowledge and awareness, respectively. This discrepancy underscores the need for more robust educational initiatives to bridge these gaps.

Digital dentistry is increasingly gaining recognition among dental instructors, as well as behavioral, interpersonal, and academic experts. To enhance their academic experience and professional prospects, dental students are encouraged to integrate digital technologies into their training. This aligns with our research findings, where 65.7% of dentists indicated that digital dentistry is child-friendly, and 81% acknowledged its potential for the future of dentistry. These findings, consistent with earlier studies, highlight a positive attitude among participants toward the adoption of digital dentistry. [12,13]

Our study observed that a significant majority (80%) of dentists were aware of CBCT (Cone Beam Computed Tomography). This aligns with Mahdizadeh et al.'s findings [14], which noted that both seasoned professionals and aspiring practitioners are familiar with CBCT and frequently recommend its use to patients. Furthermore, CBCT is a requirement in routine clinical practice across all specialties in dental universities. However, a study by Sathawane et al. [15] revealed that general practitioners are less acquainted with advanced technology, primarily recognizing

The introduction of new technologies necessitates a balanced mindset that evaluates both their benefits and limitations. In our study, over 70% of dentists advocated for incorporating knowledge of digital dentistry into the pre-clinical curriculum. This perspective aligns with Balabaskaran et al.'s research [16], where a majority of undergraduate students expressed a desire for digital dentistry to be included in pre-clinical sessions to ensure their skills remain up-to-date.

Additionally, our study revealed that over 47% of dentists use intraoral cameras for screening and 3D printing techniques. This contrasts with the findings of Sri H et al. [17], who reported that 74.5% of dentists did not use intraoral scanners, while only 25.5% had adopted these devices in their practices.

Compared to dental and non-dental professionals, dental professionals exhibit higher levels of expertise. This may result from increased knowledge acquisition through practice and a stronger inclination toward adopting technological advancements, reflecting a deeper comprehension of digital dentistry. This trend underscores their potential for growth and skill development.

Interestingly, there was no significant variation in knowledge levels based on expertise or field of practice. Addressing challenges related to perceived deficiencies—such as expertise, laboratory support, and time constraints—could further improve outcomes in digital dentistry.

This study highlights the importance of continuous dental training, improved access to equipment, and the integration of modern digital dental techniques at both undergraduate and

postgraduate levels. Such measures can enhance dentists' understanding and capabilities, ultimately leading to better patient care and satisfaction. Notably, higher levels of knowledge and comprehension were observed among academic personnel and dentists working in well-equipped settings, emphasizing the need for equitable access to resources and training opportunities.

Limitations:
The study's primary limitation lies in its sample demographics, as it predominantly included general practitioners (76.7%) and had a higher representation of females (62.4%). Geographic constraints, focusing solely on Rajasthan, limit the generalizability of findings to broader populations. Additionally, self-reported data may introduce bias, potentially affecting the accuracy of the reported attitudes and practices. Future research could benefit from a larger, more diverse sample and include objective assessments of digital dentistry competencies.

CONCLUSION:
This study highlights variations in knowledge, awareness, and perceptions of digital dentistry among dental practitioners in Rajasthan, with urban practitioners demonstrating higher familiarity and application than their rural counterparts. Despite a generally high understanding, gaps in digital dentistry education persist, emphasizing the need for enhanced theoretical and hands-on training at undergraduate and postgraduate levels. Policymakers should prioritize funding and resources to integrate these programs, particularly for rural practitioners. Organizing workshops and courses across public and private dental faculties can further bridge the knowledge gap and promote the efficient adoption of digital technologies.

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