

Knowledge, Awareness, and Perception of Digital Dentistry in Lahore Medical and Dental College: A Cross-Sectional Study

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Abstract

Background: Rapid Digitalization of dentistry has changed the way treatment planning is being done, and awareness must be created in medical institutions to familiarize the faculty with the latest innovations.

Objectives: The objective of the study was to identify the knowledge, awareness and perception of Digital Dentistry among dentists in Lahore Medical and Dental College.

Materials and Methods: Hundred participants filled the questionnaire to assess the knowledge, awareness, and perception of digital dentistry in Lahore Medical and Dental College, Lahore, Pakistan. The survey consisted of questions assessing the participants' knowledge of digital dentistry including advantages, uses, disadvantages of CAD-CAM technology, CAD-CAM systems and materials used in clinical applications. Score for each participant was calculated and categorized as low, moderate and high. Data was analyzed using SPSS and Mann-Whitney U test was done to compare differences between all the groups.

Results: Eighty-seven percent were aware of digital technology in dentistry and 77% were aware of the clinical applications of CAD-CAM technology. The median scores for knowledge, awareness and perception in the study population were 14 (IQR: 6.99), 4 (IQR: 1.76), and 13 (IQR: 2.33) respectively. The level of knowledge and awareness was moderate whereas perception was high among the participants.

Conclusion: The study showed that perception of digital dentistry was high whereas knowledge and awareness was moderate therefore policies must be developed to include trainings at an institutional level.

Keywords: Awareness, CAD/CAM, Digital Dentistry, Knowledge, Perception

Introduction

Recent advancements in Digital Dentistry (DD) have reshaped the field of dentistry as this era has changed the way patients were treated previously. Digitalization of conventional dentistry has led to reduced chair-side time, fewer appointments and reduced workload on dental clinicians and staff. ¹ Technological advancements have made treatment planning more accurate and efficient, leading to improved patient care. Computer-aided design and manufacturing (CAD/CAM) technology is being extensively used for crown and bridge fabrication, implant surgery guides, orthognathic surgery, mini-plate guides, onlay and inlay fabrication. In addition, Cone Beam Computed Tomography (CBCT) also allows for precise imaging. ²

The rapid digitization of the dental field has many clinical advantages, including enhanced quality of care leading to more accurate diagnostic-based decisions. ³ The combination of advanced dental materials and cutting-edge technology, including CAD/CAM, prosthetic software, 3D printers, 3D intraoral and facial scanners, CBCT and dental implant planning software, is greatly transforming the field of dentistry. ³ Such practices can reduce the workload of clinicians and also cater to a wider population at a lesser cost. ⁴ In a comprehensive review conducted by F. Carrillo-Pérez et al., it was found that advances in DD have the most promising prospects in treatment planning and esthetic dentistry procedures. ⁵ Although there has been a massive shift towards digitalization globally, the adoption of current practices in dentistry is still in its infancy in countries like Pakistan. The challenges faced locally are related to high costs, untrained staff, lack of infrastructure, techniques

and unavailability of opportunities to integrate digitalization into an academic setting. ⁶

Previous studies have also highlighted the need to create awareness and understanding of digitalization amongst practitioners and students. ⁷⁻¹² A survey conducted in India by Nayakar et al. showed that 96.67% of respondents had adequate awareness of CAD/CAM technology, with 87.7% believing that lack of proper knowledge was a major shortcoming and proposing an increase in awareness and knowledge. ¹³ The same study also highlighted that teaching faculty were more aware of digital technology compared with private clinicians; however, lack of knowledge was found to be the main limiting factor in adopting digitalization. ¹³ Local studies conducted across Lahore and Karachi suggest that although dentists have knowledge and awareness of DD, they still lack the hands-on training needed to implement these techniques. ¹⁴

There is limited data available in Pakistan, particularly in academic settings where educational and training programs can impact the understanding of DD. The awareness, knowledge and perception of dentists regarding DD will reflect the need for improvement and successful implementation of digitalization. The aim and objective of our study is to assess the knowledge, awareness and perception of digital dentistry among dentists at Lahore Medical and Dental College, including house officers, demonstrators, postgraduate trainees and faculty members. The study will also provide insight into the different digital techniques and materials used and ways to increase awareness, incorporate training programs and make digital dentistry a compulsory part of clinical training.

Materials and Methods

This cross-sectional descriptive study was conducted in Lahore Medical and Dental College (LMDC), Lahore, Pakistan from 6th January 2025 to 25th February 2025. Approval from the Ethical Review Board (ERB) of the college (letter no FO/5449/24) was obtained and all faculty members, demonstrators, post graduate trainees and house officers were included in the study while undergraduate students were excluded from the study. Hundred participants were recruited through non-probability convenience sampling and their confidentiality and anonymity were ensured. A self-administered, validated, questionnaire consisting of 23 questions was adapted from an Egyptian study. ¹⁵ The first part consisted of demographic details (designation, gender, age group, years of experience, and specialty). The second part had five questions based on the evaluation of knowledge of uses, advantages and disadvantages

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of CAD-CAM technology. The third part evaluated the participants' awareness of the uses of CAD-CAM systems. For both awareness and knowledge sections, each correct answer was given 1 point and 'No' ways given 0 points. The fourth part of the questionnaire consisted of seven questions assessing the practice and perception of CAD-CAM technology. Responses were given a score of 2 for 'yes', 1 for 'no' and 0 for 'not sure'. The score for each participant was calculated as follows:

Knowledge score: Low; 0-8, Moderate; 9-17, High; 18-26

Awareness score: Low; 0-3, Moderate; 4-7, High; 8-10

Perception score: Low; 0-4, Moderate; 5-9, High; 10-14

Data analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0 and the qualitative variables were described as percentages and frequencies. Descriptive statistical analysis was done, and quantitative variables were presented as median Inter quartile range (IQR). The Mann-Whitney U test was used to compare differences between the groups. For more than two groups, Kruskal-Wallis test was done. Significant association between the questionnaire items and designation and speciality of the dentists was established by Chi-Square test. Significance level was set at 0.05.

Results

There were 100 dentists in the study out of which 30% were males and 70% were females. The distribution of participants by their demographic criteria is given in Table 1. Majority (82%) of the participants were in the age range 20-29 years and had less than 5 years of clinical experience. Designation wise, a large majority of the participants were House officers (53%), Demonstrators (23%), Faculty members (15%) and Post-graduate Trainees (PGs) (9%). General dental practitioners (GDP) formed majority of the study population (79%) and 21% specialist practitioners (3% Prosthodontics, 5% Orthodontics, 4% Oral Surgery, 3% Restorative and 6% others). The median and Inter quartile range (IQR) of each score of awareness, knowledge and perception in the study variables is given in Table I along with the p value as calculated by Mann-Whitney U test. The median scores for knowledge, awareness and perception in the study population were 14 (IQR: 6.99), 4 (IQR: 1.76), and 13 (IQR: 2.33) respectively. The level of knowledge, awareness and perception in the study population is shown in the bar chart in Figure 1. The frequency of responses given to questions related to knowledge, awareness and perception is given in Table II, Table III and Table IV respectively.

There was no statistical difference between the scores for knowledge, awareness and perception based on gender, specialty and designation of dentists ($p > 0.05$). Only statistical difference was based on number of years of clinical experience ($p=0.012$) for the awareness score. In terms of knowledge, 32% of GDPs and 42% specialists had a high level of knowledge of Digital Dentistry whereas there was no statistical difference in level of knowledge amongst the participant's designation wise ($p=0.650$). GDPs (54%) and Specialists (61%) had moderate levels of Awareness whereas only 20% of the participants had high levels of awareness which included only the faculty members ($p=0.03$). The vast majority, GDPs (79.8%) and specialists (85%) had a high perception of DD with 100% faculty members having a high perception level ($p=0.04$).

Seventy-seven percent of the participants were aware of the clinical applications of CAD-CAM technology and 87% were aware of digital technology in dentistry. Participant awareness of the CAD-CAM systems was as follows; Lava (26%), Distributed Control System (DCS) (16%), Chair side Economical Restoration of Esthetic Ceramic (26%) and Procera (29%). Awareness regarding materials most used with CAD-CAM systems were Emax (51%), Zirconia (54%), Metals (21%), Composite (11%). Only 24% of the participants had attended any workshop on CAD-CAM but 87% of them wanted to incorporate this practice in their daily workflow. Eighty-seven percent of them wanted to include digital dentistry into undergraduate and postgraduate courses. Ninety-seven percent believed in the positive role of DD in the future of dental clinical practice.

Table 1: Distribution of the participants by their demographic criteria

Demographic Variables	No. (n=100)	Median IQR Knowledge Score	Median IQR Awareness Score	Median IQR Perception Score
Gender				
Male	30	15.00 (10.40)	4.50 (3.00)	12.00 (2.00)
Female	70	14.00 (15.00)	4.00 (2.00)	13.00 (2.00)
p value		0.548	0.057	0.635
Designation				
Faculty Member	15	14.00 (15.00)	5.00 (2.00)	13.00 (3.00)
Demonstrator	23	16.00 (10.00)	4.00 (3.00)	13.00 (2.00)
*PG Trainee	9	9.00 (14.00)	4.00 (3.50)	13.00 (0.50)
House Officer	53	14.00 (13.00)	4.00 (2.00)	12.00 (2.00)
p value		0.449	0.060	0.420
Experience				
< 5 years	82	14.00 (13.00)	4.00 (2.00)	13.00 (2.00)
5-10 years	6	22.00 (14.75)	6.00 (3.75)	13.00 (4.00)
>10 years	12	13.00 (17.50)	5.00 (3.50)	12.50 (2.75)
p value		0.161	0.012	0.616
Speciality				
*GDP	79	14.00 (13.00)	4.00 (2.00)	13.00 (2.00)
Specialist	21	12.00 (16.00)	4.00 (3.00)	13.00 (2.00)
p value		0.662	0.134	0.815

Table 2. Distribution of Knowledge Scores among Participating Dentists

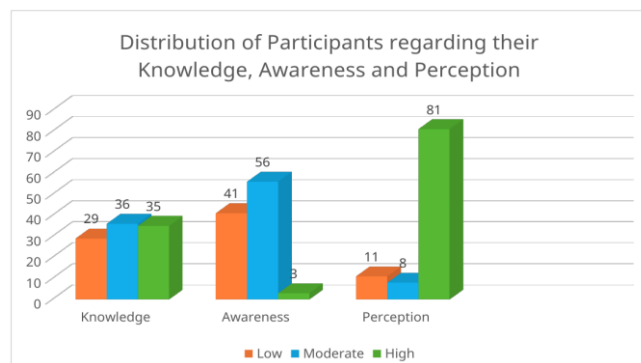
Item	Responses (%)
1. Procedures in digital dentistry	• Crown & bridge fabrication (70%) • Implant restoration (60%) • Impression making (62%) • Maxillofacial prosthesis (55%) • Surgical reconstruction (50%) • Smile designing (65%) • Invisible orthodontics (44%)
2. Uses of CAD/CAM in dentistry	• Intraoral scanning (61%) • Digital impressions (64%) • Shade matching (38%) • Computer-aided designing (64%) • Computer-aided manufacturing (59%)
3. Advantages of CAD/CAM	• Reduced appointments (68%) • Less chairside time (61%) • Greater precision than conventional methods (76%) • Digital data flow (46%)
4. Clinical advantages of CAD/CAM	• Eliminates impression errors (63.6%) • Allows preparation review/modification (60.6%) • Immediate data transfer and retrieval (60.6%) • Ease in lab communication (51.5%) • Accurate restoration fit (53.5%) • Precise orthodontic movement (28.3%)
5. Shortcomings of CAD/CAM use	• High cost (85%) • Lack of infrastructure (44%) • Lack of knowledge (47%) • Preference for conventional methods (13%)

Table 3. Distribution of Awareness Scores among Participating Dentists

Item	Responses (%)
1. Awareness of CAD/CAM technology and clinical applications in dentistry	• Yes (77%) • No (13%)
2. Awareness of the use of digital technology in dentistry	• Yes (87%) • No (11%)
3. CAD/CAM systems known to participants (select all that apply)	• LAVA™ (26%) • Distributed Control System (DCS) Precident (16%) • Chairside Economical Restoration of Esthetic Ceramics (CEREC) (24%) • Procera (29%)
4. Materials used with CAD/CAM systems (select all that apply)	• Emax (51%) • Zirconia (54%) • Metals (21%) • Composites (11%)

Table 4. Distribution of Perception/Practice Scores among Participating Dentists

Item	Responses (%)
1. Opinion on digital dentistry's role during the COVID-19 scenario	• Yes (82%) • No (10%) • Not sure (1%)
2. Attendance in training program or workshop on CAD/CAM	• Yes (24%) • No (76%)
3. Need to increase knowledge regarding DD in undergraduate/postgraduate courses	• Yes (87%) • No (11%) • Not sure (2%)
4. Interest in incorporating CAD/CAM into regular workflow	• Yes (87%) • No (6%) • Not sure (7%)
5. Preference of CAD/CAM over conventional methods	• Yes (88%) • No (1%) • Not sure (11%)
6. Belief that DD affects clinical decision-making	• Yes (77%) • No (10%) • Not sure (13%)
7. Belief that DD will have a positive impact on the future of dental practice	• Yes (97%) • No (1%) • Not sure (2%)

**Figure 1: Distribution of Participants regarding their Knowledge, Awareness and Perception**

Discussion

Adequate and quality health care for the growing population in developing countries has become a challenge for health care professionals because of underdeveloped healthcare infrastructures and untrained staff.⁴ Digital health tools aim to improve health care delivery, boost patient engagement while aiding health education.¹⁶ In the study population of Lahore Medical and Dental College, the participants had moderate awareness and knowledge of Digital Dentistry whereas the score for perception was high. These scores were similar across all the groups, showing that although the level of awareness and knowledge was moderate, 97% of the population believed that DD would have a positive impact on the future of dentistry. In our study, 87% were aware of digital dentistry, with 77%

most aware of CAD/CAM technology. These figures are comparable to another study conducted by Hajra et al., where 96.4% of participants were aware of digital dentistry, with CBCT and intraoral scanners being the most popular choices and 98.6% supporting structured training workshops. Participants of the same study cited high cost (68.7%) and lack of training (61.5%) as the major barriers to the use of CAD/CAM technology.¹⁴

In the current study, it was interesting to note that only the faculty members had high levels of awareness as well as perception, highlighting the need to increase awareness of digital dentistry at the undergraduate level. In a similar study done in Karachi, findings showed limited knowledge of CAD/CAM technology among pre-clinical students of dentistry. Even though 50% of students thought that DD played an important role in the future of dentistry, most of the dental students of public and private sectors had no practical experience with CAD/CAM.¹

There was no difference in awareness, knowledge and perception scores in all the groups. Despite the high level of perception of the participants, only 24% attended any training workshop to learn about digital technology. In a similar study in Egypt, done to evaluate awareness, knowledge and perception of digital dentistry, it was found that 47.3% had moderate knowledge, 64.2% had moderate awareness and 75.9% had a high perception of DD.¹⁵ The faculty in this study had a significantly higher score in contrast to our study, where there was no statistical difference between the scores for knowledge, awareness and perception based on specialty and designation of dentists ($p > 0.05$).

Participants in the present study had most knowledge of the use of digital dentistry for crown and bridge fabrication (70%) as well as smile design (65%). Participants were aware of the uses and clinical advantages of CAD/CAM technology, including intraoral scanning, digital impressions and computer-aided designs, offering greater precision than conventional methods, reduced appointments and less chair-side time. The majority of the participants (85%) believed that high cost was the biggest barrier to the use of CAD/CAM, although lack of infrastructure and knowledge were also cited as contributors. In a similar study conducted amongst dentists of Lahore, 95% were aware of CAD/CAM technology despite 79.5% never having attended any training workshops, although 94% believed that digital dentistry would positively impact their professional growth and 93.6% endorsed the need to teach undergraduates and postgraduates.² These figures highlight the need for training workshops and programs to make CAD/CAM teaching a part of the curriculum, as both need to be implemented together.¹⁷

Digitalization of dentistry across the globe has been assessed in many surveys and has been documented in the literature. In a study done in Egypt, it was found that about half of the participants had moderate knowledge and awareness, while 75.9% had high perception.¹⁵ In a 2016 survey in the UK, it was found that 89% of the dentists surveyed believed that CAD/CAM had a promising role in the future. This study also revealed that the dentists believed Zirconia and lithium disilicate had gained popularity over other materials. Fifty-five percent did not use any form of CAD/CAM, citing high cost as one of the reasons.⁹ Whereas in the Netherlands, usage of digital-based techniques was also very high.¹⁸ In a study done in Turkey, it was found that patients found digital impressions more comfortable than conventional impressions, further highlighting the advantage of patient ease due to digital dentistry.¹¹ A survey conducted of Saudi dentists documented 75.4% of the participants showing inclination and a positive attitude towards CAD/CAM technology.¹⁹ In a 2019 survey conducted in Switzerland of members of the Swiss Dental Association, it was found that digital technologies were an integral part of the dental practice, routinely used for patient management.²⁰

Our study has helped identify greater precision than conventional methods and elimination of impression errors as the biggest advantages of CAD/CAM technology, with high cost being the biggest shortcoming. CAD/CAM technology is most popular for crown and bridge fabrication and smile design. Materials most popular for use with CAD/CAM are Emax and Zirconia. The biggest

limitation of our study is that data was not collected from undergraduates, as their level of awareness is critical to planning for inclusion of DD in the curriculum. For future studies, the authors suggest institutional comparison of awareness of DD in Lahore and identification of the factors hindering the implementation of training for digital technology at an institutional level. There is a need to implement DD techniques in the undergraduate curriculum, including training workshops, so that the gap between awareness and practical application can be bridged.

Conclusion

This study shows that awareness and perception of the dentists is high and is in line with international trends suggesting that Digital Dentistry is the way of the future and policies must be developed to

include it at an institutional level and undergraduate curriculum. Adoption of digital dentistry in Pakistan remains restricted because of lack of training opportunities and measures despite the willingness of clinicians to learn more about it. There is little practical implementation, and policies must be developed to upgrade the dental healthcare system by improving the clinical workflow through advanced digital procedures and innovation in the dental profession by ensuring curricular integration at the same time.

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Author Contributions

1. **Fatima Suhaib:** Study design, supervision, analysis and interpretation, literature search, and manuscript writing.
2. **Mehak Hasnain:** Conception, study design, and data collection and/or processing.
3. **Abdul Moiz bin Hamid:** Conception, study design, and data collection and/or processing.
4. **Maleeha Nayyer:** Analysis and interpretation, literature search, and manuscript writing.
5. **Asfia Saeed:** Analysis and interpretation, literature search, and manuscript writing.
6. **Nadia Munir:** Funding, materials/resources, and critical review of the manuscript.