Original Article

KNOWLEDGE AND PERCEPTION OF SENIOR DENTAL STUDENTS REGARDING DIGITAL DENTISTRY AND ITS USE IN PROSTHODONTICS

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https://doi.org/10.51847/g4KsNSaNdK

ABSTRACT

Technology is becoming an ongoing expense as dentists across the globe expect Digital Radiology, Computer-Aided Design and computer-aided manufacturing (CAD/CAM), and 3D Cone Beam technology to be utilized in every practice in the future. To keep up with the rapidly increasing demand for digital technology in dentistry and meet new dental Accreditation Council (CODA) standards, dental education is making a solid transition to actively integrate technology into the curriculum. This is a cross-sectional study conducted among the senior dental students of Riyadh using an online survey. 412 students from clinical levels (8 to 12) were utilized in this study. The findings revealed that the majority of participants were female and in their 6th year of dentistry. 61.6% have a CGPA of more than 4.1 and were students of REU. They marked their knowledge as a moderate and positive attitude toward digital dentistry. 77.2% thought it could be storage of comprehensive data set, and 85.8% thought it could improve the quality of treatment and experience of patients too. The majority of them think that digital radiography needs lesser exposure. 63.5% of participants were aware of CAD-CAM, and CEREC was the first device. 85.4% think dentistry should be included in pre-clinic courses. In the present study, the knowledge about digital dentistry was moderate, and CEREC was the first device they used, but the majority were not aware of smile design in intraoral cameras.

Key words: Dental students, Digital dentistry, Prosthodontics, Cross-sectional.

Introduction

The latest developments in the field of dentistry involve the implementation of digital technologies to enhance the quality of treatments and all forms of the patient experience. Digital dentistry comprises a large number of technologies that have brought communication, documentation, manufacturing, and the use of computer-based algorithms for dental treatment. Digital technology is developing significant changes in restorative care. Some of these technologies are as follows: digital radiography, intraoral imaging/optical impression, computer-aided Design/Computer-Aided Manufacturing (CAD/CAM), shadow matching, digital smile design, Virtual articulator and digital facial arch, laser, occlusal and temporomandibular joint (TMJ) analysis and diagnosis, dental photography (extraoral and intraoral), and practice and patient record management-including digital patient education [1].

When these technological advances are fully utilized, significant milestones in the fields of medicine and dentistry can be achieved. Teledentistry is a combination of telecommunications technology and dental practice, showing the potential to enhance diagnosis and related treatments [2].

Technology is becoming an ongoing expense as dentists across the globe expect Digital Radiology, Computer-Aided Design and computer-aided manufacturing (CAD/CAM), and 3D Cone Beam technology to be utilized in every practice in the future. To keep up with the rapidly increasing demand for digital technology in dentistry and meet new dental Accreditation Council (CODA) standards, dental education is making a solid transition to actively integrate technology into the curriculum [3].

The latest advances in dentistry include the adoption of various forms of digital technology to improve the quality of care and patient experience. These benefits have prompted dental educators to incorporate digital dental technology into the dental curriculum. This current generation of dental students grew up in the digital age and is good at using emerging technologies. These benefits have prompted dental educators to incorporate digital dental technology into the dental curriculum. This current generation of dental students grew up in the digital age and is good at using emerging technologies [4, 5].

The initial purpose of the integration of digital technology in dental education was to partially solve some educational problems. For example, using optical scanning to provide

instant feedback and visualization can be used as a teaching tool. This has led to feedback that more consistent and improved student self-evaluation uses computer algorithms to set tolerance values and calculate student performance goals, thereby reducing subjective evaluation. Dental educators are committed to incorporating their efforts into the dental curriculum.In short, the results show that dental students hold more digital technologies and are more active than traditional technologies [6].

In the United Kingdom, most dentists believe that CAD/CAM technology has led to changes in the use of dental materials, leading to an increase, for example, the use of zirconium oxide and lithium disilicate. Most users have received training, and one-third of them think their training is not enough. The majority of respondents (89%) believe that CAD/CAM can play an important role in the future. Most interviewees did not use any part of the digital workflow, but most of the dentists surveyed are interested in including CAD/CAM in their workflow and most believe it will play an important role in the future [7].

In a survey in Pakistan, findings revealed that the students have heard of CBCT used in dental practice. Most of them acquired knowledge about CBCT through undergraduate courses. Many students believe that CBCT should be taught at the clinical stage of their education, and it is necessary to open a CBCT unit in the school of dentistry. More than half of the students believe that the use of CBCT will be more widespread soon, and they are eager to use CBCT technology in their future careers [8].

Benefits of the study
The findings of this study may help develop undergraduate curriculums in a way that they include modern technology to be taught at the earliest level of education.

Scope of the study
This study focused mainly on the knowledge and perception of senior dental students in Riyadh regarding digital dentistry in Prosthodontics.

Study hypotheses
Knowledge about digital dentistry is low but the perception is positive and encouraging.

Aims of the study
- To determine the knowledge and perception of senior dental students regarding the use of digital dentistry in Prosthodontics.
- To compare the responses based on dentistry year and gender.

Materials and Methods

Study design
This is a cross-sectional study conducted among the senior dental students of Riyadh using an online survey.

Study sample
412 students from clinical levels (8 to 12) were utilized in this study.

Study instrument
Online questionnaire was constructed consisting of questions related to demographic data followed by questions including knowledge and perception towards the use of digital dentistry in Prosthodontics.

Instrument Validity and Reliability
We conducted a pilot study by sending the survey to 20 participants and insert the data into SPSS version 22 to calculate Cronbach's coefficient alpha (value 0.648). The validity of the questionnaire was tested by sending it to experienced researchers at REU and modifications were made according to feedback and comments.

Statistical analysis
Collected data were analyzed using SPSS version 22, where descriptive as well as inferential statistics were conducted. Comparisons between groups were made with the value of significance kept under 0.05 using the Chi-square test.

Results and Discussion

Table 1. Frequencies

Variable	Frequency Percentage
Gender	
Male	38.8%
Female	61.2%
Dentistry Year	
4th Year	16.9%
5th Year	24.7%
6th Year	58.4%
Current CGPA	
Less than 2.5	5%

2.6 to 4	33.3%
4.1 or more	61.6%
University	
REU	39.7%
KSU	19.6%
NPU	29.2%
Others	11.4%
What is your current perceived knowledge regarding digital dentistry?	
Low	23.3%
Moderate	55.7%
High	21%
What is your current perceived attitude towards digital dentistry?	
Positive	76.7%
Negative	8.2%
Not sure	15.1%
Digital dentistry can enable the storage of comprehensive patient datasets?	
Yes	77.2%
No	8.2%
I do not know	14.6%
Can digital dentistry improve the quality of dental treatment and patient experience?	
Yes	85.8%
No	6.4%
I do not know	7.8%
Can digital dentistry provide greater marginal accuracy and internet fit of crowns?	
Yes	81.3%
No	6.8%
I do not know	11.9%
Does Digital Radiography require less exposure?	
Yes	64.4%
No	12.3%
I do not know	23.3%
Awareness about CAD/CAM?	
Yes aware	63.5%
Not aware	8.7%
Not aware but keen to know	27.9%
First CAD/CAM device?	
CEREC	54.3%
LAVA OS	5.9%
iTERO	6.8%
E4D	3.2%
Do not know	29.7%
Awareness about intraoral scanners?	
Yes aware	63%
Not aware	13.2%
Not sure	23.7%
Which smile design has an intraoral camera?	
CEREC	11.9%
CEREC II	20.1%
LAVA OS	20.1%
E4D	7.8%
Do not know	40.2%

Titanium oxide powder is used in which CAD/CAM system?	
CEREC	14.6%
CEREC II	26.9%
LAVA OS	0%
E4D	12.8%
Do not know	45.7%
Which latest Nanosized silica and zirconia-based revolutionary material is used with CAD-CAM devices?	
PARADIGM	8.7%
VIDENT	13.7%
VITA MARK II	55.3%
LAVA ULTIMATE	15.1%
Do not know	7.3%
CAD/CAM are used to fabricate (most commonly)?	
Crown	49.8%
Endocrown	8.2%
Inlay/Onlay	13.7%
Not sure	28.3%
Would you prefer/recommend using CA/CAM for digital impressions?	
Yes	88.6%
No	11.4%
Do you think dentistry should be included in pre-clinical courses?	
Yes	85.4%
No	7.8%
Do not know	6.8%

Table 2. Comparison across Gender

Variable	Male	Female	P-value
What is your current perceived knowledge regarding digital dentistry?			
Low	28.2%	20.1%	.000
Moderate	65.9%	49.3%	
High	5.9%	30.6%	
What is your current perceived attitude towards digital dentistry?			
Positive	76.5%	77.6%	.815
Negative	7.1%	9.7%	
Not sure	16.5%	12.7%	
Digital dentistry can enable the storage of comprehensive patient dataset?			
Yes	76.5%	77.2%	.405
No	5.9%	8.2%	
I don't know	17.6%	14.6%	
Digital dentistry can improve the quality of dental treatment and patient experience?			
Yes	91.8%	82.1%	.093
No	2.3%	8.9%	
I don't know	5.9%	8.9%	
Digital dentistry can provide greater marginal accuracy and internet fit of crowns?			
Yes	84.7%	79.1%	.515
No	4.7%	8.2%	
I don't know	10.6%	12.7%	
Digital Radiography requires less exposure?			
Yes	56.5%	69.4%	.139
No	14.1%	11.2%	
I don't know	29.4%	19.4%	

Awareness about CAD/CAM?			
Yes aware	65.9%	61.9%	.093
Not aware	3.5%	11.9%	
Not aware but keen to know	30.6%	26.1%	
First CAD/CAM device?			
CEREC	56.5%	52.9%	0.39
LAVA OS	7.1%	5.2%	
iTERO	29.4%	29.9%	
E4D	1.2%	10.4%	
Don't know	5.9%	1.5%	
Awareness about intraoral scanners?			
Yes aware	65.9%	61.2%	.630
Not aware	10.6%	14.9%	
Not sure	23.5%	23.9%	
Which smile design has intra oral camera?			
CEREC	8.2%	11.9%	.044
CEREC II	17.1%	20.1%	
LAVA OS	17%	20.1%	
E4D	5.9%	7.8%	
Don't know	51.8%	40.2%	
Titanium oxide powder is used in which CAD/CAM system?			
CEREC	14.1%	14.9%	.010
CEREC II	20%	31.3%	
LAVA OS	00%	00%	
E4D	7.1%	16.4%	
Don't know	58.8%	37.3%	
Which latest Nanosized silica and zirconia-based revolutionary material is used with CAD-CAM devices?			
PARADIGM	8.7%	5.9%	.000
VIDENT	13.7%	17.2%	
VITA MARK II	55.3%	20.1%	
LAVA ULTIMATE	15.1%	10.4%	
Do not know	7.3%	46.3%	
CAD/CAM are used to fabricate (most commonly)?			
Crown	49.8%	49.3%	.612
Endocrown	8.2%	8.9%	
Inlay/Onlay	13.7%	15.8%	
Not sure	28.3%	26.1%	
Would you prefer/recommend using CA/CAM for digital impressions?			
Yes	91.8%	86.6%	.239
No	8.2%	13.4%	
Do you think dentistry should be included in pre-clinical courses?			
Yes	83.5%	86.6%	.433
No	10.6%	5.9%	
Don't know	5.9%	7.5%	

Table 3. Comparison across Dentistry Year

Variable	4th year	5th year	6th year	P value
What is your current perceived knowledge regarding digital dentistry?				
Low	28.2%	18.1%	19.1%	.000
Moderate	65.9%	51.3%	50.3%	
High	5.9%	30.6%	30.6%	

What is your current perceived attitude towards digital dentistry?				
Positive	75.5%	79.6%	80.6%	.345
Negative	8.1%	7.7%	8.7%	
Not sure	16.5%	12.7%	14.7%	
Can digital dentistry enable the storage of comprehensive patient datasets?				
Yes	74.5%	78.2%	75.2%	.756
No	6.9%	7.2%	9.2%	
I do not know	18.6%	14.6%	15.6%	
Can digital dentistry improve the quality of dental treatment and patient experience?				
Yes	90.8%	80.1%	80.1%	.905
No	3.3%	9.9%	10.9%	
I do not know	5.9%	9.9%	8.9%	
Can digital dentistry provide greater marginal accuracy and internet fit of crowns?				
Yes	82.7%	75.1%	74.1%	.086
No	6.7%	10.2%	10.2%	
I do not know	10.6%	14.7%	15.7%	
Does Digital Radiography require less exposure?				
Yes	54.5%	66.4%	65.4%	.231
No	16.1%	14.2%	15.2%	
I do not know	29.4%	19.4%	19.4%	
Awareness about CAD/CAM?				
Yes aware	63.9%	58.9%	57.9%	.076
Not aware	5.5%	14.9%	15.9%	
Not aware but keen to know	30.6%	26.1%	26.1%	
First CAD/CAM device?				
CEREC	56.5%	52.9%	52.9%	0.76
LAVA OS	7.1%	5.2%	5.2%	
iTERO	29.4%	29.9%	29.9%	
E4D	1.2%	10.4%	10.4%	
Don’t know	5.9%	1.5%	1.5%	
Awareness about intraoral scanners?				
Yes aware	62.9%	60.2%	63.2%	.345
Not aware	12.6%	15.9%	12.9%	
Not sure	24.5%	23.9%	23.9%	
Which smile design has an intraoral camera?				
CEREC	10.2%	12.9%	15.9%	.546
CEREC II	15.1%	19.1%	16.1%	
LAVA OS	15%	20.1%	22.1%	
E4D	7.9%	8.8%	7.8%	
Do not know	51.8%	39.2%	38.2%	
Titanium oxide powder is used in which CAD/CAM system?				
CEREC	15%	14%	19.9%	.018
CEREC II	20%	32%	27.3%	
LAVA OS	00%	00%	00%	
E4D	10%	14.4%	15.4%	
Don’t know	55%	39.3%	38.3%	
Which latest Nanosized silica and zirconia-based revolutionary material is used with CAD-CAM devices?				
PARADIGM	10.7%	8.9%	6.9%	.000
VIDENT	11.7%	15.2%	16.2%	
VITA MARK II	54.3%	22.1%	18.1%	
LAVA ULTIMATE	16.1%	10.4%	12.4%	
Do not know	7.3%	44.3%	46.3%	

CAD/CAM are used to fabricate (most commonly)?				
Crown	44.8%	46.3%	45.3%	
Endocrown	10.2%	9.9%	10.9%	
Inlay/Onlay	14.7%	16.8%	17.8%	.675
Not sure	30.3%	27.1%	26.1%	
Would you prefer/recommend using CA/CAM for digital impressions?				
Yes	90.8%	80%	76.4%	.876
No	9.2%	20%	14.6%	
Do you think dentistry should be included in pre-clinical courses?				
Yes	80.5%	80.6%	84.6%	
No	19.6%	10.9%	6.9%	.498
Do not know	9.9%	8.5%	8.5%	

In the present study, we investigated the knowledge of senior dental students about digital dentistry and its use in prosthodontics. In the first analysis of frequency, the findings revealed that the majority of participants were female and in their 6th year of dentistry. 61.6% have a CGPA of more than 4.1 and were students of REU **(Table 1)**. They marked their knowledge as a moderate and positive attitude toward digital dentistry. 77.2% thought it could be storage of comprehensive data set, and 85.8% thought it could improve the quality of treatment and experience of patients too. 81.3% agreed that digital dentistry provides greater marginal accuracy and fits crowns. The majority of them think that digital radiography needs lesser exposure. 63.5% of participants were aware of CAD-CAM, and CEREC was the first device

Awareness about intraoral scanners was also good for the majority, and 40.2% do not know about smile design which has an intraoral camera. 45.7% do not know about the CAD/CAM in Titanium powder, while the second-leading answer was CEREC II. 55.3% think VITA MARK II is the latest Nanosized silica and zirconia-based material used in CAD/CAM devices. CAD/CAM is used to fabricate Crowns, according to the majority, and 88.6% preferred CAD/CAM for digital impressions. 85.4% think dentistry should be included in pre-clinic courses.

The majority did not know which CAD/CAM system Titanium oxide is used, but the second majority answer was CEREC II for both groups. The majority of females were not aware of Nanosize material, but males thought of VITA MARK II as the material **(Table 2)**. Both groups agreed with crowns as the material for which CAD/CAM is used to fabricate. The majority preferred CA/CAM impression and thought dentistry should be included in pre-clinical courses. In further analysis, we explored the differences across dentistry years. The findings revealed that findings reported significant differences across university, knowledge, and Nanosized silica or zirconia material while non-significant across others. The CGPA of all three groups was more than 4.1 in the majority. 5th year and 6th year were from NPU, and 4th-year students were from REU in the majority. . The majority did not know which CAD/CAM system Titanium oxide is used, but the second majority answer was CEREC II for the 4th year and LAVA OS for 5th and 6th-year students **(Table 3)**. All groups agreed with crowns as the material for which CAD/CAM is used to fabricate. The majority preferred CA/CAM impression and thought dentistry should be included in pre-clinical courses.

In the present study, we investigated the knowledge and perception of senior dental students about digital dentistry and its use in Prosthodontics in Saudi Arabia. A cross-sectional survey design and simple random sampling were used to collect the data. After ensuring the normality and reliability analysis, further analysis was carried out via SPSS, and Chi-square was used to test the comparisons between groups.. The majority in the present study were in their 6th year of dentistry and had a CGPA of more than 4.1, but in the previous study, fewer responses were from senior years, but their CGPA was higher [9]. It could also improve patients' quality of treatment and experience, and the previous study reported that 70% said it was beneficial for storing patient data and improving patient satisfaction and service efficiency [1].

The majority agreed that digital dentistry provides greater marginal accuracy and fits crowns. The majority of them think that digital radiography needs lesser exposure which is also supported by previous research, which states that CAD-CAM, according to 50% of respondents, improves crown marginal accuracy and internal fit. Digital radiography needs less exposure, according to 90% of pupils [1]. A significant proportion of participants were aware of CAD-CAM, and CEREC was the first device. Studies also supported this as they also reported that CEREC was chosen by the majority [5]. The majority think VITA MARK II is the latest Nanosized silica and zirconia-based material used in CAD/CAM devices. CAD/CAM is used to fabricate Crowns, according to the majority, and 88.6% preferred CAD/CAM for digital impressions. 85.4% think dentistry should be included in pre-clinic courses [5].

In the differences across gender, most male participants were in their 5th year while females were in their 6th year. The CGPA of both groups was more than 4.1 in the majority. Females were from NPU, and males were from REU in the majority. Perceived knowledge was moderate

in both groups, and positive attitudes and studies reported the same as the knowledge level among participants was moderate [5]. Both groups agreed that it could enable the storage of patient data sets and improve the treatment and patient experience. Both groups think that it can provide marginal accuracy and fit crowns [1]. In differences across dentistry years, perceived knowledge was moderate in all groups and positive attitude. Both groups agreed that it could enable the storage of patient data sets and improve the treatment and patient experience. All groups think that it can provide marginal accuracy and fit of crowns. The majority did not know for which CAD/CAM system Titanium oxide is used, but the second majority answer was CEREC II for 4th year, and LAVA OS for 5th and 6th-year students and studies also reported the following results that the CEREC system, according to the participants, is the first CAD-CAM design, the LAVA OS is the second most popular gadget, according to participants [5].

The majority of 5th and 6th year were not aware of Nanosize material but 4th year thought VITA MARK II was the material studies reported that LAVA ULTIMATE is one of the most recent breakthroughs CAD-CAM solutions, which is essentially a mix of Nanosized silica particles and zirconia. All groups agreed with crowns as the material for which CAD/CAM are used to fabricate. Studies also reported that Out of fabrication of Inlay/Onlay, Crowns, and Endocrown, most of the participants replied to considering the usual restoration fabricated by the use of CAD-CAM devices was the Crown, and then Endocrown and Inlay and Onlays. The vast favored CA/CAM impression and thought dentistry should be included in pre-clinical courses [5].

Conclusion

In the present study, the knowledge about digital dentistry was moderate, and CEREC was the first device they used. However, the majority were not aware of smile design in intraoral cameras. The majority were unaware of Titanium oxide use and Nanosized silica and zirconia in CAD/CAM. The most common restoration through CAD/CAM was crowns.

Acknowledgments: We would like to acknowledge the help of Riyadh Elm University research center.

Conflict of interest: None

Financial support: None

Ethics statement: This study fulfills the ethical requirements of Riyadh Elm University

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