ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 9, Issue – 4, July – 2024 , Page No. : 174 – 184

Awareness about The Knowlegde of Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) Technologies among The Dental Professions – A Survey

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Citation this Article: Dr. Santosh Dixit, Dr. Shraddha Ganesh Jambhe, Dr. Varun Deshpande, Dr. Vikram Rathod, Dr. Umashree Davangere, Dr. Satish Yadav, Dr. Shubham Jadhav, Dr. Diksha Fegade, "Awareness about The Knowlegde of Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) Technologies among The Dental Professions – A Survey", IJMSIR - July - 2024, Vol – 9, Issue - 4, P. No. 174 – 184.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Computer-aided design (CAD) and computer-aided manufacturing (CAM) have become an increasingly popular part of dentistry over the past 25 years. Computer-aided design (CAD) and computer-aided manufacturing (CAM) have been applied in implant dentistry for the design and fabrication of prosthetic frameworks and prosthetic abutments, smile designing, intraoral scanner, and many more. To take certain steps regarding increase awareness among dentist, this study aimed to evaluate the awareness in dentist's professions about CAD-CAM systems technologies. We randomly selected 410 participants and were asked 16 questions regarding the same topics. The statistic evaluation was

done by applying Chi square test. The result was found that most of the post graduates have knowledge and are aware about CAD-CAM compared to undergraduates and practitioners. So, to conclude the study suggest that we should implement the techniques of CAD-CAM in syllabus of undergraduates or should arrange seminars regarding the awareness of advancing technologies in dentistry for dental practitioners.

Keywords- CAD-CAM, Intraoral scanner, Extraoral scanner, Digital impression, milling, 3-D Printing.

Introduction

Computer-aided design (CAD) and computer-aided manufacturing (CAM) have become an increasingly popular part of dentistry over the past 25 years.[5] Three pioneers in particular who contributed to the development of dental CAD/CAM systems are Duret, Moermann, and Anderson.[1]

Duret developed the Sopha® system, which had an impact on the later development of dental CAD/CAM systems. He produced the first dental CAD/CAM restoration in 1983 and demonstrated his system at the French Dental Association's International Congress in November 1985 by creating a posterior crown restoration for his wife in less than an hour. Also Duret stated that, "The systems will continue to improve in versatility, accuracy, and cost effectiveness and will be a part of routine dental practice in coming time". Incorporation of these systems into dental practice is yet limited. Dentists should get training and access to these systems, technologies, and developments. We must combine new and conventional technologies to meet the patient demands.[1]

In the past few decades, technological advances have been incorporated in dentistry, particularly for the transfer of the spatial positions of the implants to a three-dimensional (3D) virtual model by utilizing computer-aided design and computer-aided manufacturing (CAD-CAM) technologies. As compared to traditional impression techniques, digital scanning performed using intraoral scanners (IOSs) has delivered clinically acceptable results in the fabrication of crowns and fixed restorations. This technique saves time, eliminates potential errors caused by the distortion of elastic impression materials and gypsum, exterminates the need for disinfection and transport to the dental laboratory, allows storage of scans, and promotes patient acceptance.[2]

Dental impressions are the tools to transfer patient information to dental laboratories. Thus, both conventional and digital impression making modalities can be used to obtain intraoral dental information of patients. Performing the process of scanning in the patient's mouth can significantly decrease errors related to impression making and fabrication of models.[3]

Currently there are two ways to generate a digital 3D model: direct intraoral digital impression with an intraoral scanner and extraoral scanning of conventional plaster casts or impressions. In contemporary clinical practice, alginate impressions are still commonly used due to simplicity reasons, adequate accuracy for diagnosis and low costs. However, the intraoral scans are very rapidly incorporated in everyday practice. Several studies have tested the performance of intraoral scanners both in vivo and in vitro and concluded that relatively precise 3D dental model representations of a patient's mouth can be performed. Digital three-dimensional imaging has gained great interest in dentistry as a mean to generate an imprint of the oral cavity. Digital dental models can overcome certain drawbacks associated with plaster models, such as patient discomfort and vulnerability. Being also advantageous in terms of cost,

time, and space required, digital models will probably soon become the new standard in clinical practice.[4]

In the past few decades, one of the technology incorporated in dentistry, is the transfer of the spatial positions of the implants to a three-dimensional (3D) virtual model by utilizing computer-aided design and computer-aided manufacturing (CAD-CAM) technologies.[2] Computer-aided design (CAD) and computer-aided manufacturing (CAM) have been applied in implant dentistry for the design and fabrication of prosthetic frameworks and prosthetic abutments.5 As compared to traditional impression techniques, digital scanning performed using intraoral scanners (IOSs) has delivered clinically acceptable results in the fabrication of crowns and fixed restorations. This technique saves time, eliminates potential errors caused by the distortion of elastic impression materials and gypsum, exterminates the need for disinfection and transport to the dental laboratory, allows storage of scans, and promotes patient acceptance.[2]

As digital dentistry continues to evolve, the use of intraoral scanners (IOS) has become more prevalent in both the laboratory setting as well as chair-side. These scanners have the potential to replace conventional dental impressions with digital scans. Application of IOS provides a series of advantages including: more patient-friendly and hygienic, time-efficient, simplicity of clinical procedures, elimination of transfer of the impression tray from the clinic to the laboratory and real-time evaluation of the clinical situation.[6]

Considering the existing controversies and the gap of information in this respect, this study aimed to know the awareness in dentist's professions about CAD-CAM systems technologies.

Material and method

The present study is a cross sectional survey performed online. The aim of the survey was to analyze the knowledge of professional dentist along with students on intraoral scanners used in day to day practice. The questions were based on recent topics on CAD-CAM system technologies. The total number of 16 questions were included into the online link including 1 question related to their name and 2 questions related to professions with years of experience in clinical practice. About 410 participants were randomly collected.

Statistical analysis

Analysis was conducted using Open epi software (version 3.04). The statistical analysis was evaluated by applying Chi-square test between the profession i.e demographic details of participants and details asked about CAD-CAM) technologies. It indicated that a significant difference at $p \leq 0.05$.

Result

Summary of Sample demographic details- (Table 1)

There were total 410 participants-106 dental undergraduates, 264 dental postgraduates, and 40 dental practitioners. With a year experience - 248 participants with less than 5 of experience, 130 participants with 5-10 years of experience, and 32 participants with more than 10 years of experience.

Summary of questions responded in details by participants – (Table 2)

From total participants, 306 participants responded that they would prefer the digital impression whereas 104 participants responded that they would prefer the conventional impression for fabrication of removable or fixed prosthesis. The total number of 344 participants responded that they would prefer digital systems for implants, Fixed partial denture (FPD), cast partial denture (CPD) and complete denture (CD).

Majority of participants of about 252 were aware of CEREC AC impression system whereas Trios 3 shape received the least response of about 116. Regarding the cause of the lack of digital impression practice, insufficient knowledge was the most common cause reported by 174 participants followed by economic reasons by 128 participants and inadequate infrastructure by 66 participants.

When asked about the CAD-CAM applications in prosthodontics, smile designing was the most commonly selected option of about 308 participants among Crown and bridge formation, Implant restorations, Shade matching, Smile designing or Maxillofacial prosthesis.

The CEREC was the most familiar CAD-CAM system reported by 286 participants from various DCS, PROCERA, CEREC and LAVA; followed by PROCERA by 270 participants. The total number of 351 participants reported that they would prefer CAD-CAM for prosthesis fabrication and the remaining 59 preferred conventional methods. 136 participants preferred a digital shade-matching system while the remaining 274 reported a visual shade-matching system.

Smile Designer PRO was the most familiar software program available for digital smile designing reported of about 232 participants from 3 Shape Smile Design, DSD App, Smile designer PRO, Planmeca Romexis, VisagiSMile and Digital Smile Design. From total 355 participants knew about the digital articulators and face bows. The most commonly reported advantage of T Scan's digital occlusal analysis over the conventional methods was monitoring believed by 284 participants followed by dynamic viewing, permanent documentation, and timed analysis. 356 participants reported that they were aware of the application of digital dentistry in fabricating surgical guides for implants whereas 54 participants were unaware. The most commonly reported difficulty with digital dentistry was lack of knowledge reported by 272 participants, followed by high-level precision and high prices. 400 participants believed that more instruction and knowledge on digital dentistry should be provided in undergraduate /postgraduate courses and the remaining 10 did not believe in more instruction and knowledge on digital dentistry in undergraduate /postgraduate courses. 406 participants believed that digital technology would benefit our dental profession and shape the future of dental care by enhancing it while the remaining 4 did not.

Summary of questions in comparison with professions (Table 3)

All the questions answered by the participants according to their knowledge when compared to profession were showed as statistically significant except for the question based on visual shade- matching system or a digital shade-matching system which showed non-significant difference between the professions of participants.

Discussion

The CAD/CAM technology has undergone significant advances since its introduction in 1980, and intraoral scanners are currently available for use in the clinical setting.[3] This cross-sectional study was performed with an aim to know the awareness in dentist's professions about CAD-CAM systems technologies.

The knowledge was tested in terms of questions asked. The preferences asked for fabrication of removable or fixed prosthesis would be digital impression or conventional impression. About 74.6% prefer Digital impression from them 79.5% were postgraduate. The undergraduates and practitioners were nearly same. We found that 83.9% of participants preferred digital system for implants prosthesis, from which 88.6% were postgraduates. It is followed by FPD about 81% and CPD about 43.4%. Computerized impressions is helping to

transfer the intra-oral state to a digital model. It correctly transports the implant position and the correctness of this operation may influence the treatment outcome.[7]

Regarding the awareness about the impression systems, the majority of the participants, about 61.5% selected CEREC AC. From them upto 69.7% were postgraduates and 20.3% were practitioners. They were followed by Oral scanner COS (about 52.7%) and Primes can (about 50.7%).

The CEREC was most familiar CAD-CAM system that reported about 69.8% participants followed by PROCERA to be about 65.9%, LAVA to be about 50.2% and DCS to be 42%.

Dr. Moermann developed the CEREC® system, which was a chairside CAD/CAM system. The emergence of this system was very innovative because it allowed same day ceramic restorations. This was a turning point and it spreaded the term CAD/CAM. Dr Andersson was the developer of the Procera ® system in 1983. Procera® system had central processing center with satellite networking centers under this unit.[1]

The 47.7% of postgraduates think insufficient knowledge is the cause of less use of digital impression practice whereas 45% of practitioners think same. But 39.6% of undergraduates think economics reason is the cause of less use.

Over 85.6% of participants prefer CAD-CAM prosthesis fabrication, from which 91.7% were postgraduates, 85% were practitioners and 70.8% were undergraduates. Computer-aided design (CAD) prosthesis facilitate a minimized inventory and allow for remote communication and collaboration between clinicians, technicians, and other parties with a potential reduction in cost, using specific software. It determines the material dimensions required, based on the physical and mechanical properties.[5]

Only 33.2 % population prefers digital shade matching system over 66.8% population prefers visual shade matching system, out of which were 70% of practitioners, 67.4% of postgraduates and 64.2% of undergraduates preference on visual shade-matching system. Conventional visual colour matching using shade guides is a relatively simple procedure and most commonly used to match tooth shades. The employment of digital methods to shade matched restorations is driven partly by an ever-increasing acceptance of digitization and automated diagnostics in dentistry—particularly by the use of intraoral scanners. Digital shade matching is based on the theory of colour spaces or colour models.8

Among the CAD-CAM applications in prosthodontics, smile designing was the most commonly selected option of about 75.1% from them 83.3% were the postgraduates. Smile designing was followed by Crown and bridge fabrication which was about 66.3%.

Smile designer PRO was the most famous software program for Digital smile designing reported by 56.6% of participants. From them 63.6% were postgraduates. Smile designer PRO was followed by Planmeca Romexis by 49.3% and VisagiSMile by 47.8%. Digital Smile Design (DSD) is a modern versatile innovative dental treatment planning tool invented by the Brazilian dentist Christian Coachman in 2007 that permits the professional in digitally design the smile of the patient from a series of pre- and post-DSD photographs. The DSD is an innovative tool that helps the clinician to create esthetically pleasing smiles. Pre-visualization drastically increases the patient's acceptance rate. The technology also makes the patient a part of the decision-making process by including their preferences.[8]

The total 81.7% of participants were known about digital articulators and facebows. From which there were 90.5% of postgraduates, 90% of practitioners and 56.6% of

undergraduates. The digital articulator is one such application in prosthetic restorative dentistry based on virtual reality that will significantly reduce the limitation of the mechanical articulator and by simulation of real patient data, allows analysis of digitized casts with regard to static and dynamic occlusion as well as jaw relation.[9]

The most commonly reported advantage of T-scan's digital occlusal analysis over conventional methods was monitoring considered by 69.3% of participants from which 75.8% were postgraduates. T scan is effective in diagnosis and management part of occlusion. It is an important evidence-based tool in modern research of occlusion and TMJ. In 1987 Maness came out with T scan to overcome conventional limitations. This system addressed many unanswered conflicts about occlusion.[10]

The 86.8% of participants were aware about the application of digital dentistry in fabricating surgical guide for implant. From which 93.9% were postgraduates, 85% were practitioners and 69.8% were undergraduates. Digital fabrication of a surgical guide with computer-aided design (CAD) requires an intraoral scan and often a cone beam computed tomography (CBCT) scan of the intended implant site. The CAD surgical guide can then be produced with computer-aided manufacturing (CAM), either by milling or printing.[11] Both students and dentists should prefer the digital workflow for surgical guide fabrication. It is less difficult and more effective than the conventional workflow. The operating time for fabricating a surgical guide is shorter with a digital workflow.

The lack of knowledge considered as difficulties in use of digital dentistry by 66.3% of participants. From total, 60.4% of undergraduates selected lack of knowledge. The high–level precision considered difficulties with digital dentistry by 74.2% of postgraduates.

The 97.6% of participants believe that more instruction and knowledge on digital dentistry should be provided in undergraduate/postgraduate course. Out of these 97.6% of participants there were 100% of postgraduates, 95% of practitioners and 92.5% of undergraduates.

The 99% of participants believe that digital technology will benefit our dental profession and shape the future of dental care by enhancing it, out of which 100% of participants were practitioners, 99.1% were undergraduates and 98.9% were postgraduates. The results of this study indicated that digital technology can be incorporated into the dental curriculum to teach students about digital technologies in implant dentistry.

The utilization of digital imaging and treatment planning technologies has greatly improved patient knowledge and communication, leading to superior oral health outcomes. Innovative techniques like CAD/CAM and laser dentistry, which are central to digital dentistry, offer precise, effective, and comfortable treatments, ultimately enhancing patient satisfaction and overall outcomes.

In summary, digital dentistry represents a paradigm shift in oral health care, revolutionizing the field and propelling it into a future of cutting-edge advancements. Through its transformative potential, it empowers dental professionals to deliver exceptional care, elevating patient experiences, and paving the way for a brighter future in dental education and oral health.[1]

Conclusion

In conclusion, the advancement of digital dentistry leads to better progress in both oral health and dental education. Through its application in digital technologies like precise imaging, efficient treatment planning, and personalized restorations, it has successfully transformed traditional practices performed in daily practice and colleges. It also had increased the substantial improvements in patient education, it enhanced

communication and understanding between dental professionals and patients.

We suggest that digital dentistry knowledge especially CAD-CAM should be applied in student's curriculum or seminars should be conducted to make them aware regarding the advances in the fields so that they be confident about using these technologies in daily practice from the beginning. Also for the practitioners, seminars/conferences should be made available regarding the same.

References

1. Zarina R, Jaini JL, Raj RS. Evolution of the Software and Hardware in CAD/CAM Systems used in Dentistry, Int J Prev Clin Dent Res 2017;4(4):284-91.
2. Önöral Ö, Kurtulmus-Yilmaz S, Toksoy D, Ozan O. Effect of angulation on the 3D trueness of conventional and digital implant impressions for multi-unit restorations. J Adv Prosthodont. 2023 Dec;15(6):290-301.
3. Zarbakhsh A, Jalalian E, Samiei N, Mahgoli MH, Kaseb Ghane H. Accuracy of Digital Impression Taking Using Intraoral Scanner versus the Conventional Technique. Front Dent. 2021 Feb 10;18:6.
4. Winkler J, Gkantidis N. Trueness and precision of intraoral scanners in the maxillary dental arch: an in vivo analysis. Scientific reports. 2020 Jan 24;10(1):1172.
5. Kapos T, Ashy LM, Gallucci GO, Weber HP, Wismeijer D. Computer-aided design and computer-aided manufacturing in prosthetic implant dentistry. Int J Oral Maxillofac Implants. 2009;24 Suppl:110-7.
6. Arikan H, Muhtarogullari M, Uzel SM, Guncu MB, Aktas G, Marshall LS, Turkyilmaz I. Accuracy of digital impressions for implant-supported complete-arch prosthesis when using an auxiliary geometry device. J Dent Sci. 2023 Apr;18(2):808-813.
7. Aakanksha Mahesh Dalal, Samruddhi Rathi, Mithelesh Dhamande, Digital Impressions in Dentistry, J Res Med Dent Sci, 2022, 10 (7): 076-081.
8. Rashid F, Farook TH, Dudley J. Digital Shade Matching in Dentistry: A Systematic Review. Dent J (Basel). 2023 Oct 27;11(11):250.
9. Shetty S. Virtual articulators and virtual facebow transfers: Digital prosthodontics!!! J Indian Prosthodont Soc. 2015 Oct-Dec;15(4):291.
10. Bathiya AS. T scan the evidence based digital occlusal analysis: A review. The Journal of Indian Prosthodontic Society. 2020 Dec 1;20(Suppl 1):S37.
11. Donker VJJ, Heijs KH, Pol CWP, Meijer HJA. Digital versus conventional surgical guide fabrication: A randomized crossover study on operator preference, difficulty, effectiveness, and operating time. Clin Exp Dent Res. 2024 Feb;10(1):e831.
12. Khurshid Z. Digital Dentistry: Transformation of Oral Health and Dental Education with Technology. Eur J Dent. 2023 Oct;17(4):943-4.

Legend Tables:

Table 1: Demographic details

Variable		Frequency	Percentage
Profession	Dental undergraduate	106	25.9
	Dental postgraduate	264	64.4
	Dental practitioner	40	9.8
Years of clinical experience	5-10 years	130	31.7
	Less than 5 years	248	60.5
	More than 10 years	32	7.8

Table 2: Questions asked to participants

Sr no.	Variable		Frequency	Percent
1.	For fabrication of removable or fixed prosthesis would you prefer the digital impression or the conventional impression?	Conventional impression	104	25.4
		Digital impression	306	74.6
2.	For which of the following prostheses would you prefer the digital systems?	Implants	344	83.9
		FPD	332	81
		CPD	178	43.4
		CD	148	36.1
3.	Which of the following impression systems are you aware of?	3M ESPE Lava chairside	200	48.8
		CEREC AC	252	61.5
		Upsera	176	42.9
		Trios 3 shape	116	28.3
		Oral scanner COS	216	52.7
		Primescan	208	50.7
		E4D Dentist	144	35.1
		iTero	200	48.8
		None	13	3.2
4.	What do you think is the cause of lack of digital impression practice?	Choose conventional methods	42	10.2
		Economic reasons	128	31.2
		Inadequate infrastructure	66	16.1
		Insufficient knowledge	174	42.4
5.	Are you aware of these CAD-CAM applications in prosthodontics?	Crown and bridge formation	272	66.3
		Implant restorations	222	54.1
		Shade matching	240	58.5
		Smile designing	308	75.1
		Maxillofacial prosthesis	186	45.4
		None	14	3.4
6.	Which of the various CAD-CAM systems are you familiar with?	DCS	172	42
		PROCERA	270	65.9
		CEREC	286	69.8
		LAVA	206	50.2
		None	38	9.3
7.	Would you prefer conventional or CAD-CAM prosthesis fabrication?	CAD CAM	351	85.6
		Conventional	59	14.4
8.	Would you prefer a visual shade matching system or a digital shade matching system?	Digital	136	33.2
		Visual	274	66.8
9.	Are you familiar with the various software programs available for digital smile designing?	3 Shape Smile Design	182	44.4
		DSD App	194	47.3
		Smile designer PRO	232	56.6

		Planmeca Romexis	202	49.3
		VisagiSMile	196	47.8
		Digital Smile Design	160	39
		none	24	5.9
10.	Do you know about digital articulators and facebows?	No	75	18.3
		Yes	335	81.7
11.	What advantages do you think T Scan's digital occlusal analysis has, over conventional methods?	Permanent documentation	202	49.3
		Dynamic viewing	274	66.8
		Monitoring	284	69.3
		Timed analysis	84	20.5
12.	Are you aware of the application of digital dentistry in fabricating surgical guide for implant?	No	54	13.2
		Yes	356	86.8
13.	What do you consider to be the difficulties with digital dentistry?	Lack of knowledge	272	66.3
		High-level precision	258	62.9
		High prices	128	31.2
14.	Do you believe that more instruction and knowledge on digital dentistry should be provided in undergraduate /postgraduate courses?	No	10	2.4
		Yes	400	97.6
15.	Do you believe that more instruction and knowledge on digital dentistry should be provided in undergraduate /postgraduate courses?	No	10	2.4
		Yes	400	97.6
16.	Do you believe that digital technology will benefit our dental profession and shape the future of dental care by enhancing it?	No	4	1
		Yes	406	99

Table 3: Variables compared in relation to the professions

Variable	Undergraduates		Postgraduates		Practitioner		p-value
	n	%	n	%	n	%	
For fabrication of removable or fixed prosthesis would you prefer the digital impression or the conventional impression							
Conventional impression	36	34	54	20.5	14	35	0.009*
Digital impression	70	66	210	79.5	26	65	
For which of the following prostheses would you prefer the digital systems							
Implants	82	77.4	234	88.6	28	70	0.001*
FPD	76	71.7	224	84.8	32	80	0.014*
CPD	42	39.6	122	46.2	14	35	0.271
CD	46	43.4	78	29.5	24	60	<0.001*
Which of the following impression systems are you aware of							
3M ESPE Lava chairside	42	39.6	140	53	18	45	0.058
CEREC AC	42	39.6	184	69.7	26	65	<0.001*

Upsera	40	37.7	120	45.5	16	40	0.369
Trios 3 shape	30	28.3	66	25	20	50	0.005*
Oral scanner COS	38	35.8	166	62.9	12	30	<0.001*
Primescan	50	47.2	140	53	18	45	0.444
E4D Dentist	34	32.1	88	33.3	22	55	0.021*
i Tero	32	30.2	144	54.5	24	60	<0.001*
NONE	9	8.5	1	0.4	3	7.5	<0.001*
Are you aware of these CAD-CAM applications in prosthodontics							
Crown and bridge formation	60	56.6	188	71.2	24	60	0.018*
Implant restorations	48	45.3	152	57.6	22	55	0.099
Shade matching	44	41.5	166	62.9	30	75	<0.001*
Smile designing	64	60.4	220	83.3	24	60	<0.001*
Maxillofacial prosthesis	50	47.2	114	43.2	22	55	0.342
None	6	5.7	6	2.3	2	5	0.227
Which of the various CAD-CAM systems are you familiar with							
DCS	18	17	147	55	7	15	<0.001*
PROCERA	56	52.8	188	71.2	26	65	0.003*
CEREC	56	52.8	208	78.8	22	55	<0.001*
LAVA	52	49.1	134	50.8	20	50	0.957
NONE	20	18.9	14	5.3	4	10	<0.001*
What do you think is the cause of lack of digital impression practice							
Choose conventional methods	12	11.3	22	8.3	8	20	0.008*
Economic reasons	42	39.6	76	28.8	10	25	
Inadequate infrastructure	22	20.8	40	15.2	4	10	
Insufficient knowledge	30	28.3	126	47.7	18	45	
Would you prefer conventional or CAD-CAM prosthesis fabrication							
CAD CAM	75	70.8	242	91.7	34	85	<0.001*
Conventional	31	29.2	22	8.3	6	15	
Would you prefer a visual shade-matching system or a digital shade-matching system							
Digital	38	35.8	86	32.6	12	30	0.753
Visual	68	64.2	178	67.4	28	70	
Are you familiar with the various software programs available for digital smile designing							
3 Shape Smile Design	32	30.2	130	49.2	20	50	0.003*
DSD App	34	32.1	142	53.8	18	45	0.001*
Smile designer PRO	42	39.6	168	63.6	22	55	<0.001*
Planmeca Romexis	34	32.1	146	55.3	22	55	<0.001*

VisagiSMile	30	28.3	146	55.3	20	50	<0.001*
Digital Smile Design	44	41.5	92	34.8	24	60	0.008*
None	13	12.3	8	3	3	7.5	0.003*
Do you know about digital articulators and facebows							
No	46	43.4	25	9.5	4	10	<0.001*
Yes	60	56.6	239	90.5	36	90	
What advantages do you think T Scan's digital occlusal analysis has, over conventional methods							
Permanent documentation	36	34	152	57.6	14	35	<0.001*
Dynamic viewing	62	58.5	184	69.7	28	70	0.106
Monitoring	60	56.6	200	75.8	24	60	0.001*
Timed analysis	28	26.4	40	15.2	16	40	<0.001*
Are you aware of the application of digital dentistry in fabricating surgical guide for implant							
No	32	30.2	16	6.1	6	15	<0.001*
Yes	74	69.8	248	93.9	34	85	
What do you consider to be the difficulties with digital dentistry							
Lack of knowledge	64	60.4	186	70.5	22	55	0.050*
High-level precision	48	45.3	196	74.2	14	35	<0.001*
High prices	44	41.5	64	24.2	20	50	<0.001*
Do you believe that more instruction and knowledge on digital dentistry should be provided in undergraduate /postgraduate courses							
No	8	7.5	0	0	2	5	<0.001*
Yes	98	92.5	264	100	38	95	
Do you believe that digital technology will benefit our dental profession and shape the future of dental care by enhancing it							
No	1	0.9	3	1.1	0	0	0.792
Yes	105	99.1	261	98.9	40	100	