

Digitalisation of Dentistry: A Pandemic Influence

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Abstract: *Digital technologies have been gradually introduced in almost all aspects of modern life. In the era of paperless technology - digitalisation does speak volumes of how well clinicians have adopted modern clinical practices. Digital technologies have revolutionized and has radically changed the practice of dentistry. COVID - 19 pandemic has played a significant role in hastening the process of digitalisation in all the fields including various aspects of dentistry. Therefore, we constituted a study to determine the pace and the status of digitalisation of dentistry and also to learn the attitude of dental professionals towards this change. The study is based on two self - administered surveys. The first survey was conducted between August 2019 and September 2019 which gives us the pre - pandemic data and the second survey was done between August 2021 and September 2021 which accounts for the post - pandemic data. Marginal Homogeneity test was used to compare the responses to the questions by the study participants between pre and post - pandemic periods. The findings of our study suggested that the majority of the dental professionals have already begun to embrace the path of modernisation of their clinical practice in almost all aspects post coronavirus disease pandemic, from utilising modern and smart technologies to maintain a digital record of patients' treatment history and organising their schedules and agendas; to digitally record radiographs, dental and periodontal charting, and have access to these data from outside their training, reducing the contact exposure between the patient and the clinician. Newer innovative computer techniques are starting to be employed in all fields of education and has been found useful in many areas of dentistry and has a great potential in revolutionizing dentistry and dental education. The digitalisation of dentistry is not just a future trend in dentistry, it is happening now in the present. The integration of digital technology into dentistry is changing the way of practice, management and communication. It depends on the dentist to well define his/her practice by adopting the leading - edge innovations in the present and future.*

Keywords: Digitalisation, COVID - 19 pandemic, Dentistry, Digital dentistry, Technology

1. Introduction

In today's quick - moving world, instant results are expected to be synonymous with worthwhile procedures which are very significant in dental healthcare systems. 'Digitisation' and 'digitalisation' are two different terms that are closely related and are often used interchangeably in a wide range of publications. *Digitisation* can be defined as the material process of converting analogue streams of information into digital bits. *Digitalisation* can be defined as the way many domains of social life are restructured around digital communication and media infrastructures. ^[1] Unlike digitisation, digitalisation doesn't have a single and clear definition, digitalization can also be defined as the use of digital technologies to change a business model and provide new revenue and value - producing opportunities. ^[2] When it comes to dentistry, it is the use of dentistry related software and technologies in dental procedures and treatments which benefits the patient as well as the operator.

Digital dentistry may be defined in a broad scope as any dental - related technology or device that involves digital or computer - aided components instead of mechanical or electrical components alone.

The commonly used digital technologies in dentistry are CAD/CAM, intraoral imaging, computer - aided implant placements, digital radiography, radiovisiography, cone beam computed tomography (CBCT), occlusion and TMJ analysis. Software for practice and patient record management, including digital patient education are also used. ^[3] Dental photography combined with particular software for image processing helps in designing patients' smiles virtually and is a valuable tool for communication, visualization and comparison in modern aesthetic and cosmetic dentistry. Intraoral scanners take an accurate optical impression of the dental arches which is replacing the classic method with tray and impression materials. It's a one - time investment which doesn't lead to wastage of any materials. CAD/CAM (computer - aided designing / computer - assisted manufacturing) technology enables dental restorations such as crowns, veneers, inlays and onlays to be fabricated using computerized milling technology. It saves an enormous amount of time for both the dentist as well as the patient. Cone Beam computed tomography (CBCT) provides dentists with quick three - dimensional images of the anatomy of patient's oral cavity and maxillofacial region and this data is used for designing personalized implants, or personalized bone grafts. ^[4] ^[5] Digital X - rays provide greater ease than conventional X -

rays and reduce radiation exposure and it also allows dentists to amplify images for greater diagnostic accuracy, ensuring more timely and proper treatment plans. Scheduling appointments online has become very common especially in pandemics and is making it easier for patients. Furthermore, communication programs make it easy for dentists to confidentially share information about a patient's case with their laboratories and specialists to ensure proper care and minimises unnecessary patient office visits.^[5]

A pandemic is a widespread occurrence of an infectious disease that has spread across a large region, for example, multiple continents or worldwide, affecting a large population. A public health emergency of international concern (PHEIC) was declared by the WHO director - general on 30th January 2020, which was later declared as a Global Pandemic in March 2020 due to the extensive spread of the coronavirus disease. ^[6] Coronavirus Disease or COVID-19 caused by SARS COV2 (severe acute respiratory syndrome coronavirus 2) is a respiratory infectious disease, where people infected with the virus will experience mild to moderate respiratory illness. ^[7] ^[8]. Coronavirus being zoonotic can be transmitted between animals and humans, and spreads from one human to another. ^[6] The symptoms caused by this virus include dry cough, high - grade fever, various multisystem problems such as breathing difficulties, loss of smell sensation, loss of taste, diarrhoea, generalized malaise, acute cardiac injury and secondary infections. ^[9]

Globally, as of 8 October 2021, there have been 23, 65, 99, 025 confirmed cases of COVID - 19, including 48, 31, 486 deaths, reported to WHO.

America is on the top of the list with the greatest number of confirmed cases (91014944 cases). In India, from 3 January 2020 to 8 October 2021, there have been 3, 39, 15, 569 confirmed cases of COVID - 19 with 4, 50, 127 deaths, reported to WHO. ^[10] The COVID - 19 pandemic has affected almost all the fields. Healthcare and education system are definitely amongst the most affected ones. COVID - 19 has had adverse effects on education which includes disruptions in learning, and reduced access to education and research facilities. The students have lost their jobs, and this has led to an increase in their student debts. It was noted that many educators and students used digital technology to ensure continued learning online during the Coronavirus pandemic. ^[11]

Similarly, healthcare also has seen detrimental effects where the patients were not able to access the basic healthcare needs, people lost their lives due to conditions that could have easily been managed. The cost of the treatment and services skyrocketed, and patients were denied treatment due to a lack of resources. Dentistry, one of the major sectors in the healthcare system has also witnessed significant changes due to the pandemic. Dentistry being a high - risk profession due to the close proximity of the doctor to the patient and aerosol generation, in most of the procedures, has seen a halt or restricted routine treatment and care. There have been severe consequences for dental education and research. Emergency and urgent care provisions have proceeded generally. However, due to the lack of appropriate and

recommended personal protective equipment, emergent patients have also been denied the treatment. Many of the oral conditions present with early signs and symptoms which must be treated early, otherwise it can progress to stages that cannot be reversed. Many nations have introduced telephone and video consultations for patients with symptoms. ^[12] These will provide a temporary solution to the patients, and it will be easier for the doctor to manage later without much harm. The use of these digital technologies in dentistry could result in increased safety and reduced transmission of COVID - 19 during the pandemic. ^[13] Digital technologies when paired with human abilities ensures improved dental and oral healthcare.

2. Literature Survey

Newer innovative computer techniques are starting to be employed in all fields of education and has been found useful in many areas of dentistry and has a great potential in revolutionizing dentistry and dental education. This is valuable to the digitalization of dentistry and its increasing treatment and diagnostic demands. Digital technologies help to arrive at a proper diagnosis which in turn ensures the correct treatment plan which is the only way to re - establish and restore the patient's normal health. Digitalization in dentistry has increased significantly over the last 10-20 years. In most developing countries, the shortage of medical and dental professionals stimulates the need for technology, especially artificial intelligence (AI) software. This can reduce costs, time, the need for human knowledge, the number of medical errors, and tackles tedious laborious tasks. ^[14]

Digitalisation is a future trend in dentistry that will enhance both practice management and treatment of patients. In the era of paperless technology - digitization does speak volumes of how well clinicians have adopted modern clinical practices.

The covid - 19 pandemic has played a significant role in hastening the process of digitalisation in all the fields including various aspects of dentistry. Although digitization is flourishing in various fields, dentistry seems to be lagging behind.

Therefore, we constituted a study to determine the pace and the status of digitalisation of dentistry and also to learn the attitude of dental professionals towards this change.

This study was done to know the significance and the impact of digitalization of dentistry on dental practice and to know the dentist's attitude towards digitalization. It was also done to know if digitalization was applied only in practice management/ or only in treatment or both. This study will also determine the covid - 19 pandemic impact on various aspects of the digitalization of dentistry.

3. Methods/ Approach

3.1 Study Design

The study is based on two self - administered surveys. The first survey was conducted between August 2019 and

September 2019 which gives us the pre - pandemic data. The second survey was done between August 2021 and September 2021 which accounts for the post - pandemic data. The calculated sample size is 228. The ethics approval for the research was obtained from Rajarajeswari Dental College and Hospital Ethics Committee. The participants involved in the study gave consent before filling out the online forms agreeing to participate in the study. The participants were assured about the confidentiality of their responses.

3.2 Questionnaire Preparation:

For this research, a questionnaire was prepared by referring various scientific articles, journals and surveys and then was subsequently pilot tested with 20 participants meeting the criteria, and necessary changes were made. Before circulating the final survey, the questions were arranged in sequential order for the better understanding by the participants and to ensure their efficiency. The demographic details such as their age, gender and work status were kept as required fields. Whereas their names and their email ids were kept optional so that the participant can remain anonymous if he/she wants to. The questionnaire consisted of 17 multiple choice questions and few of them had the option of multiple answers. The questionnaire ended with the participant’s suggestions on the cost and efficiency of the newly available digital technology which was purely subjective.

3.3 Data Collection

An online platform, Google Forms was used to collect the data in both the surveys. These google forms were circulated to various dental institutions and private practitioners by sending e - mails to them and further circulated through many social media platforms such as WhatsApp, Instagram, Telegram and Facebook. The selection criteria for the study were the post - graduate students (1st year, 2nd year and 3rd year) dental faculty and dental private practitioners. Post - graduate students, faculty and practitioners from Bangalore were selected. The online form was answered by over 225 participants in both surveys. The responses of the participants who did not meet the selected criteria were removed. All the responses were recorded and tabulated in the required format and the data collected was monitored on a daily basis.

3.4 Statistical Analysis

Statistical Package for Social Sciences [SPSS] for Windows Version 22.0 Released 2013. Armonk, NY: IBM Corp., will be used to perform statistical analyses.

3.5 Descriptive Statistics

The descriptive analysis includes the expression of responses to the study questionnaire using frequency and proportions.

3.6 Inferential Statistics

The marginal homogeneity test was used to compare the responses to the questions by the study participants between pre and post - pandemic periods.

The level of significance was set at $P < 0.05$.

4. Results/ Discussion

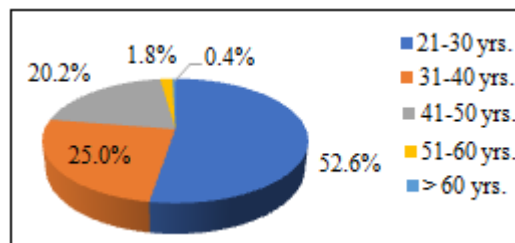


Figure 1: Age wise distribution of study participants in 2019

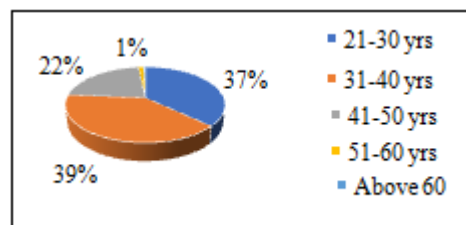


Figure 2: Age Wise Distribution of Study Participants in 2021

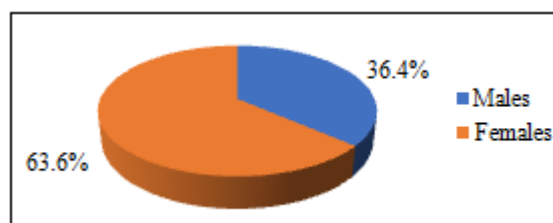


Figure 3: Gender wise distribution of study participants in 2019

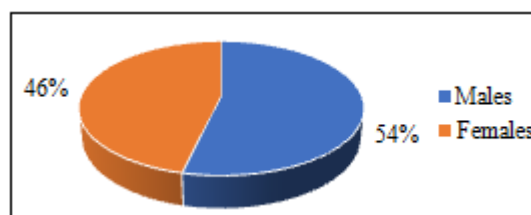


Figure 4: Gender wise distribution of study participants in 2021

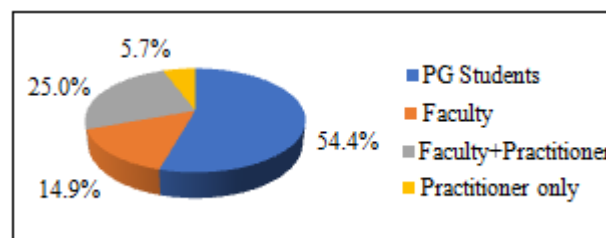


Figure 5: Distribution of study participants based on Work Profile in 2019

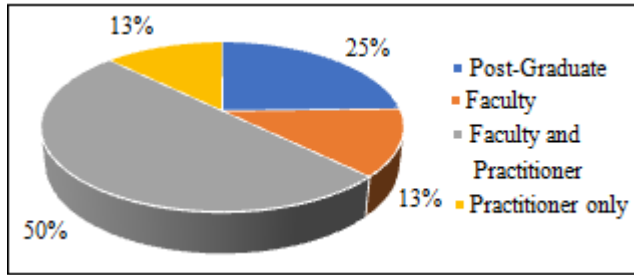


Figure 6: Distribution of study participants based on Work Profile in 2021

A total of 228 participants were surveyed in 2019, out of which 145 (63.6%) were females and 83 (36.4%) were males. Of all participants, 120 (52.6%) belonged to the age group 21 - 30 years, 57 (25.0%) belonged to the age group 31 - 40 years, 46 (20.2%) belonged to the age group 41 - 50 years, 4 (1.8%) belonged to 51 - 60 years and 1 (0.4%) belonged to the age group above 60 years. There were 124

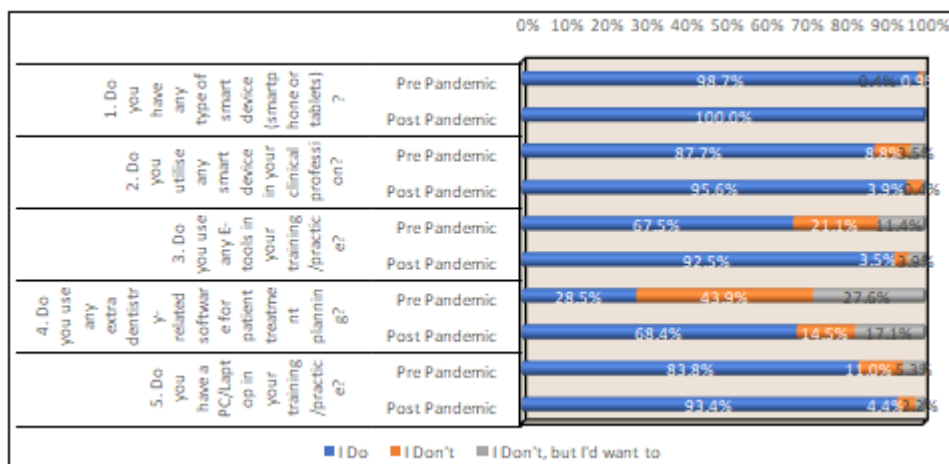
(54.4%) post - graduate students, 34 (14.9%) faculties only, 57 (25.0%) practicing faculties and 13 (5.7%) practitioners only.

Whereas in 2021, a total of 244 participants were surveyed, out of which 113 (46.3%) were females and 131 (53.7%) were males. Of all participants, 90 (36.9%) belonged to age group 21 - 30 years, 96 (39.3%) belonged to age group 31 - 40 years, 54 (22.1%) belonged to age group 41 - 50 years, 3 (1.2%) belonged to 51 - 60 years and 1 (0.4%) belonged to the age group above 60 years. There were 60 (24.6%) post - graduate students, 31 (12.7%) faculties only, 122 (50%) practicing faculties and 31 (12.7%) practitioners only.

A Marginal Homogeneity test was used to compare the responses to the questions by the study participants between pre and post - pandemic periods.

Table 1: Comparison of responses for questions on use of smart phones / e - tools in dental training / practice between 2 time periods using Marginal Homogeneity test

Questions	Responses	Pre Pandemic		Post Pandemic		MH Value	P - Value
		n	%	n	%		
1. Do you have any type of smart device (smartphone or tablets) ?	I Do	225	98.7%	228	100.0%
	I Don't	2	0.9%	0	0.0%		
	I Don't, but I'd want to	1	0.4%	0	0.0%		
2. Do you utilise any smart device in your clinical profession?	I Do	200	87.7%	218	95.6%	3.150	0.002*
	I Don't	20	8.8%	9	3.9%		
	I Don't, but I'd want to	8	3.5%	1	0.4%		
3. Do you use any E - tools (for example: A - V aids, webinars) in your training/practice?	I Do	154	67.5%	211	92.5%	5.578	<0.001*
	I Don't	48	21.1%	8	3.5%		
	I Don't, but I'd want to	26	11.4%	9	3.9%		
4. Do you use any extra dentistry - related software, other than the administration software for your patient treatment planning?	I Do	65	28.5%	156	68.4%	6.480	<0.001*
	I Don't	100	43.9%	33	14.5%		
	I Don't, but I'd want to	63	27.6%	39	17.1%		
5. Do you have a PC/Laptop in your training/practice?	I Do	191	83.8%	213	93.4%	3.074	0.002*
	I Don't	25	11.0%	10	4.4%		
	I Don't, but I'd want to	12	5.3%	5	2.2%		



Graph 1: Responses for questions on use of smart phones / e-tools in dental training /practice between 2 time periods

The test results showed that there was a significant increase in the utilization of smart devices [95.6%] at P=0.002, during the post - pandemic period with an increase of approximately 8% as compared to the pre - pandemic period. A significant increase of 25%, leading to the majority of participants [92.5%] using some e - tools in their dental practice during the post - pandemic period as compared to

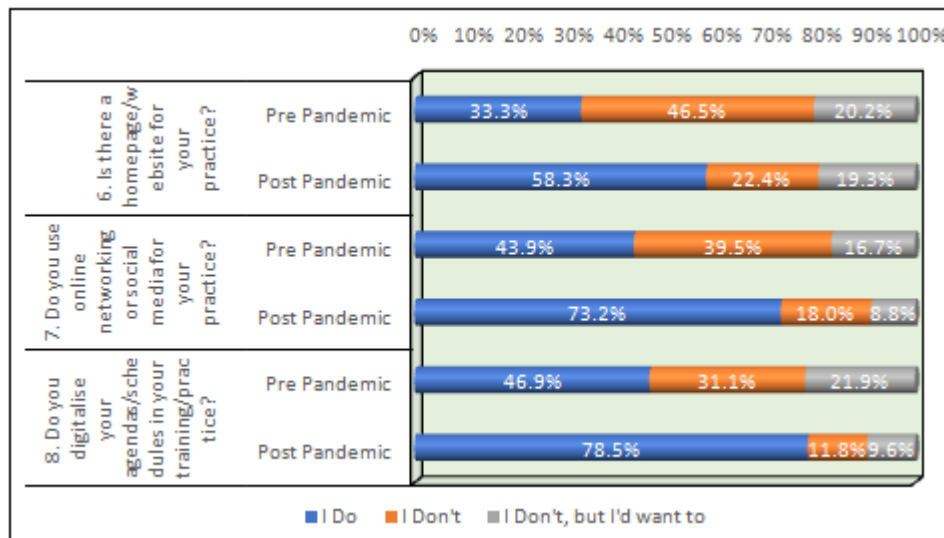
67.5% during the pre - pandemic period [<0.001].68.4% of the participants during the post - pandemic period were using extra dentistry related software for patient treatment planning as compared to only 28.5% during pre - pandemic period, leading to an approximate increase of 40% which was statistically significant at $P<0.001$.93.4% of the study participants during the post - pandemic period had a laptop

or PC in their dental practice as compared to 83.8% during the pre - pandemic period. This increase in 10% of the participants using the laptop or PC was statistically significant at P=0.002. However, no significant difference

was observed with respect to possession of smart devices between pre and post - pandemic periods among the study participants.

Table 2: Comparison of responses for questions on use of website / social media / networking in dental training /practice between 2 time periods using Marginal Homogeneity test

Questions	Responses	Pre Pandemic		Post Pandemic		MH Value	P - Value
		n	%	n	%		
6. Is there a homepage/website for your practice?	I Do	76	33.3%	133	58.3%	8.016	<0.001 *
	I Don't	106	46.5%	51	22.4%		
	I Don't, but I'd want to	46	20.2%	44	19.3%		
7. Do you use online networking or social media for your practice?	I Do	100	43.9%	167	73.2%	5.545	<0.001 *
	I Don't	90	39.5%	41	18.0%		
	I Don't, but I'd want to	38	16.7%	20	8.8%		
8. Do you digitalise your agendas/schedules in your training/practice?	I Do	107	46.9%	179	78.5%	8.631	<0.001 *
	I Don't	71	31.1%	27	11.8%		
	I Don't, but I'd want to	50	21.9%	22	9.6%		



Graph 2: Responses for questions on use of on use of website / social media / networking in dental practice between 2 time periods

As a result of the pandemic, 58.3% of the study participants had homepage/websites for their clinical practice as compared to only 33.3% during the pre - pandemic period with an increase of 25% which was statistically significant at P<0.001.

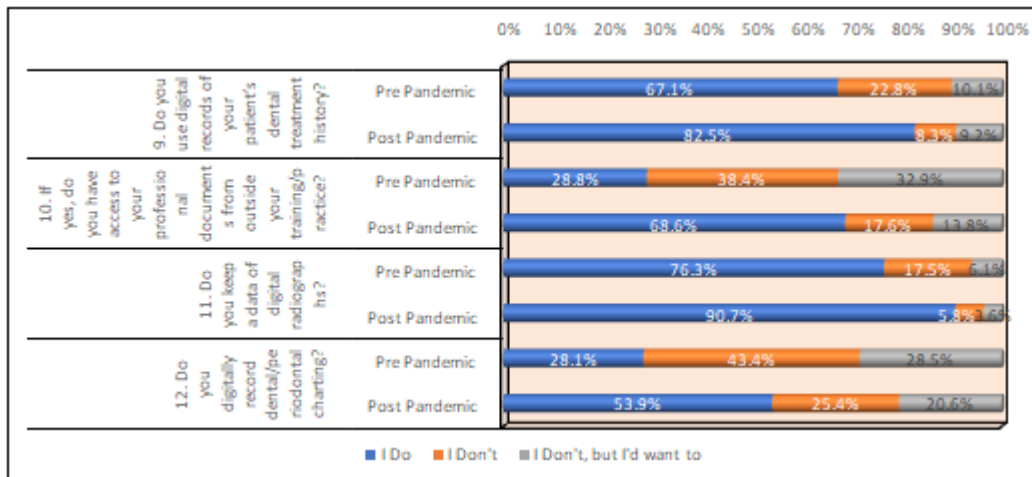
practice as compared to 43.9% during the pre - pandemic period [P<0.001].

73.2% of the study participants during the post - pandemic period used online networking or social media for their

31.6% increase was seen in study participants in the post - pandemic period [78.5%] who opted for digitalising agendas/schedules in their clinical practice, as compared to 46.9% in the pre - pandemic period which was statistically significant at P<0.001.

Table 3: Comparison of responses for questions on use of digital patient records & Digital Radiographs in dental practice between 2 time periods using Marginal Homogeneity test

Questions	Responses	Pre Pandemic		Post Pandemic		MH Value	P - Value
		n	%	n	%		
9. Do you store/use digital records of your patient's dental treatment history?	I Do	153	67.1%	188	82.5%	2.752	0.01 *
	I Don't	52	22.8%	19	8.3%		
	I Don't, but I'd want to	23	10.1%	21	9.2%		
10. If yes, do you have access to your professional documents from outside your training/practice?	I Do	63	28.8%	144	68.6%	6.675	<0.001 *
	I Don't	84	38.4%	37	17.6%		
	I Don't, but I'd want to	72	32.9%	29	13.8%		
11. Do you keep a data of digital radiographs?	I Do	174	76.3%	204	90.7%	3.528	<0.001 *
	I Don't	40	17.5%	13	5.8%		
	I Don't, but I'd want to	14	6.1%	8	3.6%		
12. Do you digitally record dental/periodontal charting?	I Do	64	28.1%	123	53.9%	4.626	<0.001 *
	I Don't	99	43.4%	58	25.4%		
	I Don't, but I'd want to	65	28.5%	47	20.6%		



Graph 3: Responses for questions on use of use of digital patient records & Digital Radiographs in dental practice between 2 time periods

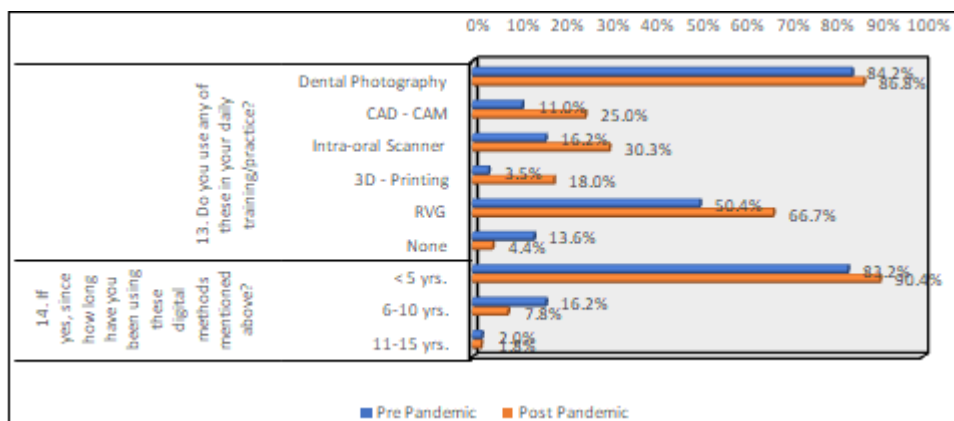
82.5% of the study participants during the post - pandemic period, stored/used digital records of their patients' dental treatment history as compared to 67.1% during the pre - pandemic period [P=0.01].

Of the participants who used/stored digital records of their patients' dental treatment history, there was a significant increase of 39.8% in the post - pandemic period (68.6%) contrary to 28.8% during the pre - pandemic period, which was statistically significant at P<0.001.

90.7% of the study participants during the post - pandemic period, kept data of their digital radiographs as compared to 76.3% during the pre - pandemic period [P<0.001]. Dental/periodontal charting was recorded digitally by 53.9% of the study participants during the post - pandemic period in contrary to 28.1% during the pre - pandemic period with a notable increase of 25.8% which was statistically significant at P<0.001.

Table 4: Comparison of responses for questions on Practice of Digital dentistry & duration of use between 2 time periods using Marginal Homogeneity test

Questions	Responses	Pre Pandemic		Post Pandemic		MH Value	P - Value
		n	%	n	%		
13. Do you use any of these in your daily training/practice?	Dental Photography	192	84.2%	198	86.8%	0.832	0.41
	CAD - CAM	25	11.0%	57	25.0%	3.771	<0.001*
	Intra - oral Scanner	37	16.2%	69	30.3%	3.491	<0.001*
	3D - Printing	8	3.5%	41	18.0%	4.919	<0.001*
	RVG	115	50.4%	152	66.7%	3.537	<0.001*
	None	31	13.6%	10	4.4%	3.550	<0.001*
14. If yes, since how long have you been using these digital methods mentioned above?	< 5 yrs.	164	83.2%	197	90.4%	3.008	0.002*
	6 - 10 yrs.	32	16.2%	17	7.8%		
	11 - 15 yrs.	4	2.0%	4	1.8%		



Graph 4: Responses for questions on Practice of Digital dentistry & duration of use between 2 time periods

Amongst the options given, dental photography was the most used in their practices with 84.2% in the pre -

pandemic period and 86.8% during the post - pandemic period.

Radiovisiography (RVG) was the second most commonly used dental technology with 50.4% of study participants using it in the pre - pandemic period and we saw an increase

of 16.3% in the usage leading to 66.7% of the post - pandemic study population [P<0.001].

The study participants using CAD/ CAM and intra - oral scanner almost doubled in the post - pandemic period compared to the pre - pandemic period.11.0% of study participants used CAD/CAM in the pre - pandemic period as compared to 25% during the post - pandemic period, which is a significant increase of 14.0% [P<0.001]. A 14.1% increase was seen in the usage of intra - oral scanners in the study participants during post - pandemic period [30.3%], as compared to 16.2% in the pre - pandemic period [P<0.001].

3 - D printing technology also saw a large increase of 14.5% with only 3.5% of the study population using it in the pre -

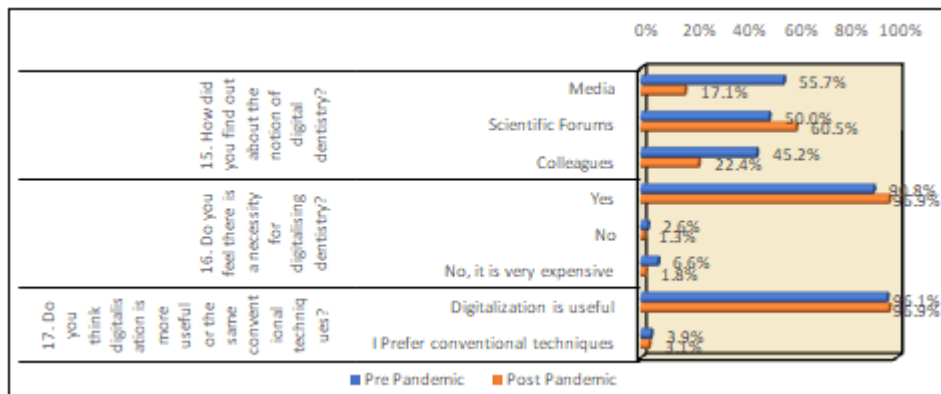
pandemic period compared to 18% during post - pandemic period [P<0.001].

13.6% used of the study population used none of the aforementioned digital dental technologies in the pre - pandemic period whereas it declined to 4.4% [P<0.001].

A noteworthy amount of the study population i. e., 90.4% has started to use the above - mentioned technology only from less than 5 years and very few of the study population i. e., 2.0% in the pre - pandemic period and 1.8% during the post - pandemic period have been using it from past 11 - 15 years [P=0.002].

Table 5: Comparison of responses for questions on perception of digitalization in dental practice between 2 time periods using Marginal Homogeneity test

Questions	Responses	Pre Pandemic		Post Pandemic		MH Value	P - Value
		n	%	n	%		
15. How did you find out about the notion of digital dentistry?	Media	127	55.7%	39	17.1%	7.718	<0.001*
	Scientific Forums	114	50.0%	138	60.5%		
	Colleagues	103	45.2%	51	22.4%		
16. Do you feel there is a necessity for digitalising dentistry, and would you be interested to digitalise further?	Yes	207	90.8%	221	96.9%	4.555	0.006*
	No	6	2.6%	3	1.3%		
	No, because I don't find it very cost efficient	15	6.6%	4	1.8%		
17. Do you think digitalisation is more useful or the same conventional techniques?	Digitalization is useful	219	96.1%	221	96.9%	0.500	0.62
	I Prefer conventional techniques	9	3.9%	7	3.1%		



Graph 5: Responses for questions on perception of digitalization in dental practice between 2 time periods

The prime source of information about the notion of digital dentistry majorly has been scientific forums 50.0% in the pre - pandemic period and 60.0% during the post - pandemic period [P=0.03].55.7% in the pre - pandemic period and 17.1% during the post - pandemic period have found out about digital dentistry through media [P<0.001].45.2% in the pre - pandemic period and 22.4% during the post - pandemic period have found out about the notion of digital dentistry through colleagues [P<0.001].

A whopping 90.8% in the pre - pandemic study population and 96.9% during the post - pandemic study population felt the necessity for digitalising dentistry and are interested to digitalise further. Only 9.2% in the pre - pandemic period and 3.1% during the post - pandemic period did not feel it necessary for digitalisation of dentistry out of which 6.6% in the pre - pandemic period and 1.8% the post - pandemic

period did not want to digitalise as they did not find it cost - efficient for their practice [P=0.006].

A vast majority of the population in the pre - pandemic period (96.1%) and post - pandemic period (96.9%) think that digitalisation is more useful than the conventional techniques. Only 3.9% and 3.1% of the study population in the pre - and post - pandemic period still prefer conventional techniques over digital dentistry.

When asked suggestions regarding the cost and efficiency of the newly available digital technologies, a number of study participants took the opportunity to offer some valuable thoughts. The following are some of the suggestions given by our study participants based on their clinical experience and knowledge of the digital dental market:

- *“If made available for larger population automatically cost per person comes down, so popularize digitalisation. It has great usage in management, following apt forensic application”*
- *“Though the cost of this digital technology is efficiently high, I would prefer this technology as we can store data in an organized manner for long term and helps in legal cases, can help to promote treatment and current generation run behind digital gadgets. ”*
- *“Digital comes at a cost, but it makes your practice highly efficient and saves a lot of time so keeping this in mind I think the cost is bearable. ”*
- *“Make it a norm and part of the curriculum in dental colleges to follow digital dentistry. ”*
- *“Education, awareness about dental health among people and also giving knowledge about digital methods & options towards services available on health management. ”*

The digitalisation of dentistry is not just a future trend in dentistry it is happening now in the present. It depends on the dentist to well define his/her practice by adopting the leading - edge innovations in the present and future^[15]

The digitalisation of the dental practice has been adopted in three major steps of the digital treatment workflow. They are “Digital Patient”, where the patients’ data is digitised for storage of the digital records; “Virtual Patient”, where mental designing of the patients’ treatment is done using digital technologies such as CAD (Computer - Aided Design); and “Real Patient”, where the treatment procedures are done with the help of CAM (Computer - Assisted Milling) or 3D printing. In recent years the modern digital technology has significantly modified the ways of approaching patients, diagnostic processes and digital planning of advanced and sophisticated treatment solutions thereby improving patients’ comfort and compliance. There is also an improvement in the treatment outcome quality, cost and time savings. This very well benefits the dentists and dental technicians too.

In addition, the COVID - 19 pandemic has tremendously driven forward the agenda of digitalization, which is clearly seen in the results mentioned above. The use of smart devices and software in digital dentistry has caused interference on many fronts, leading to the rise of various new methods, techniques and systems that improve the field as a whole. Even with all the disruptions due to the modernization of dentistry, the plethora of advantages weigh out the disadvantages. These new innovations have impelled a lot of future research and development opportunities, giving way to evolving greater effectiveness, efficiency and accuracy in the skills and capabilities of those involved.^[16]

The findings of our study suggested that the majority of the dental professionals have already begun to embrace the path of modernisation of their clinical practice in almost all aspects post coronavirus disease pandemic, from utilising modern and smart technologies to maintain a digital record of patients’ treatment history and organising their schedules and agendas; to digitally record radiographs, dental and periodontal charting, and have access to these data from outside their training reducing the contact exposure between

the patient and the clinician. For the majority of people these days, a product or a business doesn’t exist if it isn’t found online. Hence it gets very important to have a strong online presence with attractive and detailed homepages and websites to their practice. This online method of networking has re - established the old conventional methods of patient referrals and promotions, to digitally endorsing their practice on various social media platforms and internet - based portals. The COVID - 19 pandemic has also highlighted the need for other digital e - tools (e. g., A - V aids, Webinars) for the purpose of networking and education.

Imaging forms the basis of all the treatment workflow in dentistry. The utilisation of various digital technologies such as intra - oral scanners which digitises the oral environment facilitating dental treatment workflow. Advanced intra - oral scanners are comparatively smaller in size with quicker scanning ability and render immediate visualisation and moves swiftly in the oral cavity. The use of intra - oral scanners has made the pandemic environment far less burdensome. The CAD/CAM technology enables a more streamlined and efficient treatment planning through reduced chairside time with reported improved satisfaction of the clinician and patient. With the help of such intra - oral scanners and CAD - CAM, the clinician doesn’t need to depend on conventional impression making techniques. This technology was crucial during the COVID - 19 pandemic since it allowed dentists/technicians to work from home without any pronounced impact on the treatment procedures and also allowed dentists to securely link from home to their office computers and function normally as usual. Dental photography is a major medium for treatment workflow. 3D printing reduces human error, and is widely used especially in cases of orthodontic diagnosis and treatment.

5. Future Scope

Further studies can be conducted to compare cost, time consumption, efficiency and other such factors between conventional and digital methods, with larger sample size. With so many advantages mentioned above, there are some drawbacks like patients’ data being hacked or getting deleted. Due to resources and time constraints, this study was limited to a small group in Bangalore.

6. Conclusion

The integration of digital technology into dentistry is changing the way of practice, management and communication. They have been a key source for accessing information and knowledge. These digital technologies pose new challenges but set new and higher goals for the dentist to achieve. It is seen that a lot of dentists hesitate to adopt these modern digital technologies due to a long learning process. To overcome this, the concept of modern digitalisation should be introduced earlier in the dental teaching curricula along with acquiring the conventional treatment workflow knowledge, which will enable and make it easier for the future generation dentists to adapt and adjust to the advancements constantly taking place in and around the digital world. The vertical amalgamation of digital technologies between the dental team and its laboratory associates enables the doctor to meet the patients’

expectation and deliver excellent outcomes with a simple yet organised process. ^[18] To increase patient well - being, control cross - contamination and staff protection, the use of digital tools will be the top priority in the post - COVID - 19 pandemic period. The dentists who put digital work pattern front and centre, encompassing digitalisation and transforms the treatment experience along with the conventional knowledge is more likely to be successful and thrive in the post pandemic - period. ^[19]

References

- [1] Brennen, J. S. and Kreiss, D. (2016). Digitalization. In *The International Encyclopedia of Communication Theory and Philosophy* (eds K. B. Jensen, E. W. Rothenbuhler, J. D. Pooley and R. T. Craig). <https://doi.org/10.1002/9781118766804.wbiect111>
- [2] Digitization, Digitalization, And Digital Transformation: Confuse Them At Your Peril - Jason Bloomberg https://moniquebabin.com/wp-content/uploads/articulate/uploads/Going-Digital4/story_content/external_files/Digitization%20Digitalization%20and%20Digital%20Transformation%20Confusion.pdf
- [3] Digital dentistry: Is this the future of dentistry? <https://www.dentaleconomics.com/science-tech/article/16394539/digital-dentistry-is-this-the-future-of-dentistry>
- [4] Francesco Mangano, Jamil A. Shibli, Thomas Fortin, "Digital Dentistry: New Materials and Techniques", *International Journal of Dentistry*, vol.2016, Article ID 5261247, 2 pages, 2016. <https://doi.org/10.1155/2016/5261247>
- [5] Digital Dentistry: Overview of Digital Dental Technologies <https://www.yourdentistryguide.com/digital-dentistry/>
- [6] Novel Coronavirus (2019 nCoV), World Health Organisation <https://www.who.int/timorleste/emergencies/novel-coronavirus-2019>
- [7] Qutob N, Awartani F (2021) Knowledge, attitudes and practices (KAP) towards COVID - 19 among Palestinians during the COVID - 19 outbreak: A cross - sectional survey. *PLoS ONE* 16 (1): e0244925. <https://doi.org/10.1371/journal.pone.0244925>
- [8] Coronavirus Disease 2019 (Covid - 19), Mayo Clinic <https://www.mayoclinic.org/diseases-conditions/coronavirus/symptoms-causes/syc-20479963>
- [9] Sharma S, Grover M, Bhargava S, Samdani S, Kataria T. Post coronavirus disease mucormycosis: a deadly addition to the pandemic spectrum. 2021; 135 (5): 442 - 447. doi: 10.1017/S0022215121000992
- [10] <https://covid19.who.int>
- [11] Impact of covid 19 on education - Edeh Michael Onyema, Nwafor Chika Eucheria, Faith Ayobamidele Obafemi, Shuvro Sen, Fyeface Grace Atonye, Aabha Sharma, Alhuseen Omar Alsayed *Journal of Education and Practice* 11 (13), 108 - 121, 2020 https://genbase.iiep.unesco.org/workspace/applis/epidoc/fichiers/EPIDOC/38698_52821_56584_1_PB.pdf
- [12] Coulthard, P., Thomson, P., Dave, M. et al. The COVID - 19 pandemic and dentistry: the clinical, legal

and economic consequences - part 1: clinical. *Br Dent J* 229, 743-747 (2020). <https://doi.org/10.1038/s41415-020-2404-y>

- [13] Markarian RA, Silva RLB da, Burgoa S, Pinhata - Baptista OH, No - Cortes J, Cortes ARG. Clinical relevance of digital dentistry during COVID - 19 outbreak: a scoped review. *Braz. J. Oral Sci.* [Internet].2021Jan.4 [cited 2021Oct.5]; 19: e200201.
- [14] The ways of using machine learning in dentistry Monika Elżbieta Machoy1, A-F, Liliana Szyszka - Sommerfeld1, B, F, Andras Vegh2, E, F, Tomasz Gedrange3, 4, E, F, Krzysztof Woźniak1, E, F 1 Department of Orthodontics, Pomeranian Medical University, Szczecin, Poland 2 Department of Orofacial Orthopaedics and Orthodontics, Heim Pal Children's Hospital, Budapest, Hungary 3 Division of Orthodontics, Technische Universität Dresden, Germany 4 Department of Oral Surgery, Wrocław Medical University, Poland
- [15] Hirschinger R. Digital dentistry: information technology for today's (and tomorrow's) dental practice. *J Calif Dent Assoc.*2001 Mar; 29 (3): 215 - 21, 223 - 5. PMID: 11324291
- [16] Rekow ED. Digital dentistry: The new state of the art - Is it disruptive or destructive? *Dent Mater.*2020 Jan; 36 (1): 9 - 24. Doi: 10.1016/j.dental.2019.08.103. Epub 2019 Sep 14. PMID: 31526522.
- [17] Zitzmann NU, Matthisson L, Ohla H, Joda T. Digital Undergraduate Education in Dentistry: A Systematic Review. *Int J Environ Res Public Health.*2020; 17 (9): 3269. Published 2020 May 7. doi: 10.3390/ijerph17093269.
- [18] Digitalization in Dentistry Taking an integrated approach to the newest technologies can yield the best results for diagnosis and treatment planning. By Arthur Z. Weiss, DMD <https://www.aegisdentalnetwork.com/id/2012/03/digitalization-in-dentistry>
- [19] Why digitalisation in dentistry is now even more important than ever <https://coronavirus.dental-tribune.com/news/why-digitalisation-in-dentistry-is-now-even-more-important-than-ever/>

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