# KNOWLEDGE OF PROSTHODONTIC POSTGRADUATES ABOUT DIGITAL DENTISTRY AND ITS ROLE IN PROSTHODONTIA: AN ORIGINAL RESEARCH

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**ABSTRACT:**
*Aim: The purpose of this study was to assess the knowledge of prosthodontics postgraduates about digital dentistry and its role in prosthodontia.*
*Methods: Electronic based questionnaire was distributed among a total of 250(n=250) postgraduate students in India. Responses were obtained from four groups: Demographic details of students, Role and Benefits of digital dental technologies, Barriers towards the implementation of technology, and impact of digital dentistry in dental education. The data were analyzed using SPSS 12.0 software with significance levels set at P < 0.05.*
*Results: Two hundred students (80%) responded to the survey. Most of the respondents did not use any part of a digital workflow, and the main barriers to use were initial costs and a lack of perceived benefit over conventional methods.*
*Conclusions: Though the usage of digital technology was limited by barriers, however, most respondents found digital technologies to be useful in fabricating definitive prosthesis with enhanced clinical outcomes and positive patient response.*

*Key Words: Barriers, Digital dental technology, Dental education, Prosthodontics, Questionnaire, Role and benefits.*

**Introduction:**
The more recent advances in dentistry have involved the adoption of digital technologies in all forms to improve the quality of care and patient experiences. Digital dentistry includes a multitude of technologies that bring the communication, documentation, manufacture, and delivery of dental treatment using computer-based algorithms.[1] Digital technology is making a significant change in the practice of Prosthodontics. Some of these technologies are as follows: Digital radiography, Intraoral imaging/optical impression, Computer-aided design/computer-aided manufacturing(CAD/CAM), Shade matching, Digital smile designing,

Virtual articulators and digital facebows, Laser, Occlusion, and temporomandibular joint (TMJ) analysis and diagnosis, Dental photography(extraoral & intraoral), and Practice and patient record management – including digital patient education.[2] Digital dental applications such as electronic patient records, selective laser sintering of complex prosthetic frameworks, the common advantages of improved communication, increased control, reduced operating time, greater quality and data archiving, and improved clinical outcome and patient experiences simply cannot be matched using conventional techniques.[3-6] While digital technology has immense influence over the clinical and laboratory procedures, education and training of students, patient motivation, practice management, and dental research.[7] The assimilation of this comprehensive knowledge and application of developing technologies can aid in the implementation of digital dentistry.[8] This study aims to assess the knowledge of prosthodontics postgraduates on digital dentistry and its role in prosthodontia.

**Materials and methods:**
Questionnaire:
In this study, a descriptive questionnaire was prepared to assess the knowledge of post-graduate students about digital dentistry and its role in prosthodontics. The questionnaire was divided into four groups: (A) Demographic details of students, (B) Role and Benefits of digital dental technologies, (C) Barriers towards the implementation of technology in dental practice, (D)The impact of digital dentistry in dental education. The questionnaire was distributed among a total of 250 postgraduate prosthodontic students from different dental institutes of India. The questionnaire form was electronic-based and distributed online through email and Whatsapp.

**Data analysis:**
Data were analyzed using SPSS (Statistical Package for the Social Sciences) version 20 (SPSS Inc., Chicago, IL, USA). For differential statistics, the chi-square test was used for individual and multiresponse analysis. The level of statistical significance was set at $P \leq 0.05$.

**Results:**
Demographic characteristics of the dental students are given in Table 1. Out of 250 students,230 responded. All the dental students were of Indian origin. There were 100 male and 130 female participants with a mean age of 27.5 years(23-32). Amongst them, first-year students (50), second-year students(80), and third-year students(100). About 78% agreed that digital technology enhances communication while 20% did not know about it.70% found it useful for the storage of patient data and also improved patient experience and quality of treatment.50% thought that it improves control of design and production of a prosthesis.50% thought that CAD-CAM enhances marginal accuracy and internal fit of crowns.90% of students were aware that digital radiography requires less exposure. Only 30% were aware of virtual articulators and digital facebows. The high cost of equipment could limit to only 30% of the usage of CAD-CAM & digital impression techniques.86% found that CAD-CAM has a role in future dentistry while 60% found guided surgery to be useful in implant placement(Table-2). About 90% of students found the high cost of equipment as a major barrier followed by others(Table-3). Around 80% found digital technology to enhance the virtual learning environment & self-assessment in dental education(Table-4).

**Table 1: Demographic details**

| SUBJECTS | TOTAL=230 |
|---|---|
| Gender | Male =100, Female=130 |
| Age in years | Average 27.5 years(23-32) |
| Year of postgraduation | First-year = 50 |
| | Second-year= 80 |
| | Third-year =100 |

| Q.NO | Questions | Response | N(%) | | | P-value |
|---|---|---|---|---|---|---|
| | | | Male | Female | Total | |
| 1. | Enhances communication | Yes | 80(34.7) | 100(43.47) | 180(78.2) | o.oo1 |
| | | No | - | - | - | - |
| | | Don't Know | 20 (8.6) | 30(13.4) | 50(21.7) | |
| 2. | Enables the storage of comprehensive patient datasets | Yes | 70(30.4) | 90(39.1) | 160 (66.8) | 0.001 |
| | | No | - | - | - | |
| | | Don't Know | 30(6.9) | 40(9.2) | 70(30.5) | |
| 3. | Improves the quality of dental treatment & patient experience | Yes | 60(26.0) | 105(45.5) | 165(71.7) | 0.001 |
| | | No | 30(13.0) | 20(8.6) | 50(21.7) | |
| | | Don't Know | 10(4.3) | 05(2.1) | 15(6.5) | |
| 4. | Improved control of the design & manufacturing | Yes | 50(21.7) | 75(32.6) | 125(54.3) | 0.051 |
| | | No | 35(15.2) | 33(14.3) | 68(29.5) | |
| | | Don't Know | 05(2.1) | 22(9.5) | 27(11.7) | |
| 5. | Greater marginal accuracy & internal fit of crowns | Yes | 50(21.7) | 70(30.4) | 120(52.1) | 0.23 |
| | | No | 45(19.5) | 35(15.2) | 80(34.70) | |
| | | Don't Know | 05(2.1) | 25(10.8) | 30(13.4) | |
| 6. | Digital radiography requires less exposure | Yes | 85(36.9) | 120(52.1) | 205(89.1) | 0.001 |
| | | No | - | - | - | |
| | | Don't Know | 15(6.5) | 10(4.3) | 25(10.8) | |
| 7. | Virtual articulators and digital facebows | Yes | 35(15.2) | 40(17.3) | 75(32.6) | 0.152 |
| | | No | 52(22.6) | 57(24.7) | 109(47.3) | |
| | | Don't Know | 13(5.6) | 33(14.3) | 46(20) | |
| 8. | CAD-CAM and digital impression technique | Yes | 30(13.0) | 45(19.5) | 75(32.6) | 0.136 |
| | | No | 70(30.4) | 85(36.9) | 155(67.3) | |
| | | Don't Know | - | - | - | |
| 9. | CAD-CAM has a big role in future dentistry | Yes | 95(41.3) | 105(45.6) | 200(86.9) | 0.021 |
| | | No | - | - | - | |
| | | Don't Know | 05(2.1) | 25(10.8) | 30(6.9) | |
| 10. | Guided surgery and dental implants | Yes | 55(23.9) | 87(37.8) | 142(61.7) | 0.012 |
| | | No | - | - | - | |
| | | Don't Know | 45(19.5) | 43(18.6) | 88(38.2) | |

**Table 3: Barriers towards the implementation of technology in dental practice**

| Q.NO | Questions | Response | N(%) | | | P-value |
|---|---|---|---|---|---|---|
| | | | Male | Female | Total | |
| 1. | Cost & availability of the equipment | Yes | 85(36.9) | 100(50.7) | 200(90.7) | 0.001 |
| | | No | 05(2.1) | 05 (2.1) | 10(4.0) | |
| | | Don't Know | 10(4.3) | 25(10.8) | 15(6.2) | |
| 2. | Lack of basic computer skills | Yes | 76(33.0) | 95(41.3) | 171(74.3) | 0.01 |
| | | No | 20(8.6) | 08(3.4) | 10 (4.3) | |
| | | Don't Know | 04(1.7) | 27(11.7) | 31(13.4) | |

| 3. | Lack of dental laboratory support | Yes No Don't Know | 88(38.2) 02(0.86) 10(4.3) | 105(45.6) 05(2.1) 20(8.6) | 193(83.9) 07(03) 30(13.2) | 0.012 |
| 4. | Need for system training | Yes No Don't Know | 90(39.1) 08(3.4) 03(1.3) | 96(41.7) 15(6.5) 19(8.2) | 186(80.8) 23 (10) 22(9.5) | 0.023 |

**Table 4: The impact of digital dentistry in dental education**

| Q.NO | QUESTIONS | Response | N(%) | | | P-value |
| --- | --- | --- | --- | --- | --- | --- |
| | | | Male | Female | Total | |
| 1. | Improves dental education | Yes No Don't Know | 95(41.3) 00 05 (2.1) | 120(52.1) 00 10(4.3) | 215(93.4) 00 15(6.5) | 0.001 |
| 2. | Digital dental technologies in preclinical and clinical courses | Yes No Don't Know | 75(32.6) 25(10.8) 00 | 85(36.9) 40(17.3) 05(2.1) | 160(69.5) 65(28.2) 05(2.17) | 0.05 |
| 3. | Provides for a virtual learning environment & enhances self-assessment | Yes No Don't Know | 90(39.1) 05(2.1) 05(2.1) | 105(45.6) 15(6.5) 10(4.3) | 195(84.7) 20(8.6) 15(6.5) | 0.015 |

**Discussion:**

The current impact of digital technology in prosthodontics is developing due to several benefits over conventional techniques. In this study, knowledge of prosthodontics postgraduates about digital dental technology was evaluated based on a survey of an online questionnaire. About 80% of students agreed that digital dentistry enhances communication between patients, dentists, laboratory technicians, and third-party providers. This can be attributed to the usage of three-dimensional imaging techniques such as radiography or surface scans which are integrated into electronic patient records thereby enhancing diagnosis, planning, and communication.[9,10] More than 70% agreed that digital records enable the storage of comprehensive patient datasets such as virtual diagnostic casts. This is advantageous by producing durable images without loss of original casts, interfacing with other images for analysis by software, and reducing the cost of storage.[11,12] Around 50% thought that digital technology improves the quality of dental treatment and imparts a positive patient experience. The improved clinical outcome can be due to 3D imaging technology that is viewed in high contrast, magnified fields on a computer screen, and often in direct sight of the patient.[13-15] More than 50% agreed that digital workflow provides improved control of the design and production of the definitive prosthesis. High accuracy and efficiency of technology aids in the proper designing and precise production of the prosthesis.[16] More than 50% thought that crown fabricated using digital technology possess greater marginal accuracy and internal fit when compared to conventional techniques.[17] Fasbinder and Chochlidakis also reported similar results in their study.[18,19] However, Tsirogiannis et al found that there was no significant difference was observed regarding the marginal gap of single unit ceramic restorations fabricated after digital or conventional impressions.[20] Less than 30% were familiar with virtual articulators and digital facebows. 90% of students were aware that digital radiography requires less exposure. Virtual articulators aids in the analysis of static and dynamic occlusion, to substitute mechanical articulators and face-bow is another aspect that allows for a more precise location of the

occlusal surface.[21,22] Less than half of students used CAD-CAM technology in their workflow. This is due to the high cost and unavailability. However, postgraduate students tend to do more complex cases where occlusal control and choice of dental materials are significant.[23] Further, the use of precious alloys such as gold is not amenable to CAD/CAM fabrication procedures.[23] Those who used CAD/CAM as part of their implant workflow felt that it allowed for precise 3D planning and could facilitate flapless implant placement.[24] More than 60% of students felt that cost & availability of the equipment is the major barrier to the implementation of digital dental technology. Most of the students were in favor of digital technology improving dental education. Likewise, it provides for a virtual learning environment and enhances self-assessment.[25] However, a recent survey showed that digital technologies and their costs are the main factors that challenge the fiscal strategies of dental colleges.[26]

**Conclusion:**

Within the limitations of the study, it can be concluded that the knowledge of prosthodontics postgraduates was quite fair especially in an academic field. Despite the advantages of digital technology, the majority of postgraduates did not use CAD-CAM in their practice at dental colleges. High initial cost and lack of availability of equipment were the main reasons for this. However, they agreed that digital technology has a significant role in future dentistry. Therefore, prosthodontics as a specialty will continue to lead the broader discipline in adopting new treatment strategies and improving clinical outcomes.

**References:**

1. Lee SJ, Gallucci GO. Digital vs. conventional implant impressions: efficiency outcomes. Clin Oral Implants Res.2013;224(1):111-115

2. Gupta C, Mittal A. Role of digital technology in prosthodontics: A step toward improving dental care. Indian J Oral Health Res. 2018;4:35-41

3. Mattias T. Advantages of Digital Dentistry (Part 2). Elos Medtech; 2017. https://www.elosmedtech.com/the-importance-advantages-of-digital-dentistry-part-2/.

4. Paul L, Child JR. Digital dentistry. Is this the future of dentistry? Dent Econ 2011;101:10.

5. Jayachandran S. Digital imaging in dentistry: A Review. Contemp Clin Dent 2017;8:193-4.

6. Lawson NC, Burgess JO. Clinicians reaping benefits of new concepts in impressioning. Compend Contin Educ Dent 2015;36:152-3.

7. E.D. Rekow. Digital dentistry: The new state of the art — Is it disruptive or destructive? Dent Mater 2020;36(1):9-24.

8. Brownstein S, Murad A, Hunt R. Implementation of new technologies in U.S. dental school curricula. J Dent Educ.2015;79:259-264.

9. Lim S, Hong SJ, Ohe JY, Paek J. Application of 3D Computed Tomography Reconstruction Images to Assess the Thickness and Dimensions of the Posterior Palatal Seal Area. Biomed Res Int. 2019;2019:7912371. Published 2019 Feb 19. doi:10.1155/2019/7912371

10. Kulczyk T, Rychlik M, Lorkiewicz-Muszyńska D, Abreu-Głowacka M, Czajka-Jakubowska A, Przystańska A. Computed Tomography versus Optical Scanning: A Comparison of Different Methods of 3D Data Acquisition for Tooth Replication. Biomed Res Int. 2019;2019:4985121. Published 2019 Apr 10. doi:10.1155/2019/4985121

11. Abduo J. Accuracy of casts produced from conventional and digital workflows: A qualitative and quantitative analyses. J Adv Prosthodont. 2019;11(2):138-146.

12. Dinkova M, Dzhonev I. 3D Archive in Dental Practice–A Technology of New Generation. www.ijsr.net/archive/v3i11/T0NUMTQxMzM3.pdf

13. Prithviraj DR, Bhalla HK, Vashisht R, Sounderraj K, Prithvi S. Revolutionizing restorative dentistry: an overview. J Indian Prosthodont Soc. 2014;14(4):333-343.

14. Pillai S, Upadhyay A, Khayambashi P, et al. Dental 3D-Printing: Transferring Art from the Laboratories to the Clinics. Polymers (Basel). 2021;13(1):157. Published 2021 Jan 4. doi:10.3390/polym13010157.

15. Oberoi G, Nitsch S, Edelmayer M, Janjić K, Müller AS, Agis H. 3D Printing-Encompassing the Facets of Dentistry. Front Bioeng Biotechnol. 2018;6:172.

16. Torabi K, Farjood E, Hamedani S. Rapid Prototyping Technologies and their Applications in Prosthodontics, a Review of Literature. J Dent (Shiraz). 2015;16(1):1-9.

17. Robles-Medina M, Romeo-Rubio M, Paz Salido M & Pradíes G. Digital Intraoral Impression Methods: an Update on Accuracy. Current Oral Health Reports.2020;7:361–375.

18. Fasbinder DJ. Computerized technology for restorative dentistry. Am J Dent. 2013 Jun;26(3):115-20.

19. Chochlidakis KM, Papaspyridakos P,Geminiani A, Chen CJ, Feng IJ, Ercoli C. Digital versus conventional impressions for fixed prosthodontics: A systematic review and meta-analysis. J Prosthet Dent. 2016 Aug;116(2):184-190.e12.

20. Tsirogiannis P, Reissmann DR, Heydecke G. Evaluation of the marginal fit of single-unit, complete-coverage ceramic restorations fabricated after digital and conventional impressions: A systematic review and metaanalysis. J Prosthet Dent. 2016 Sep;116(3):328-335.e2.

21. Solaberrieta E, Garmendia A, Minguez R, Brizuela A, Pradies G. Virtualfacebow technique. J Prosthet Dent 2015;114:751-5.

22. Bisler A, Bockholt U, Kordass B, Suchan M, Voss G. The virtual articulator. Int J Comput Dent 2002;5:101-6.

23. Tran D, Nesbit M, Petridis H. Survey of UK dentists regarding the use of CAD/CAM technology. Br Dent J. 2016 Nov 18;221(10):639-644.

24. Joda T, Brägger U. Digital vs. conventional implant prosthetic workflows: a cost/time analysis. Clin Oral Implant Res 2014; 26: 1430–1435.

25. Hamil L, Mennito A, Renné W, Vuthiganon J. Dental students' opinions of preparation assessment with E4D compare software versus traditional methods. J Dent Educ. 2014; 78:1424-1431.

26. McAllister D, Garrison G, Feldman C, Anderson E, Cook B, Valachovic R. U.S. Dental School Deans' Perceptions

27. Turkyilmaz I, Lakhia S. Challenges to Digital Dentistry in Dental Schools. J Contemp Dent Pract. 2019 Dec 1;20(12):1361.