



Fusing Tradition with Innovation: CAD/CAM Adoption Throughout Dental Discipline's: A descriptive study

Dr. Aditi Vashisht (post graduate), Dr Varun Kumar (professor and HOD), Dr Geeta Arya (reader)

Department of Prosthodontics and crown and bridge, Seema dental college and hospital

(Received: 16 July 2025

Revised: 20 August 2025

Accepted: 02 September 2025)

KEYWORDS

Cad-Cam,
Dental
Students,
Prosthodont
ist,
Advanced
Technology
Knowledge.

ABSTRACT:

Introduction: The present study investigates the awareness and adoption of CAD/CAM (Computer-Aided Design and Manufacturing) technology among dental professionals and students in Uttarakhand, Delhi, and Uttar Pradesh. As dentistry transitions from traditional manual methods to digital workflows, CAD/CAM is increasingly influencing all specialties, including prosthodontics, orthodontics, restorative dentistry, oral surgery, implantology, and periodontology.

Objectives: To assess current awareness levels, identify challenges in adoption, evaluate training exposure, and understand perceptions of CAD/CAM's benefits across dental disciplines.

Methods: A structured and validated online questionnaire was distributed to 500 participants, including undergraduate and postgraduate students, and dental practitioners. Responses were analysed to evaluate knowledge, application, and attitudes toward CAD/CAM.

Results: While awareness of CAD/CAM technology was generally high, its actual usage remained limited. The most cited barriers were lack of hands-on training, insufficient academic exposure, and infrastructural or financial constraints. However, both students and professionals expressed a strong desire to learn and incorporate CAD/CAM into clinical practice. Existing users reported high satisfaction, especially in terms of improved accuracy, reduced chairside time, and enhanced efficiency.

Conclusions: The study highlights the urgent need to integrate CAD/CAM into dental curricula and continuing education programs. Overcoming educational and infrastructural barriers can promote broader adoption and prepare future dentists for a more digital, precise, and interdisciplinary approach to care. Embracing CAD/CAM is essential for aligning dental practice with global trends toward innovation and personalized treatment.

1. Introduction

The advent of "digital workflow" might be regarded as an iconic event in dentistry. The development of digital dentistry has resulted to a remarkable transformation in everyday clinical practice due to the synergy between new digital technologies and significant advances in the mechanical and aesthetic features of dental materials. This reduces treatment times while maintaining high standards of precision and aesthetics.^{1,2}

Determining how successfully the dental profession has responded to contemporary technology innovations requires an understanding of the degree of awareness of digital dentistry among dental practitioners. This goal is to assess the level of familiarity that dental professionals and students have with digital processes, such as 3D

printing, intraoral scanners, and CAD-CAM technologies. The study will determine if digital dentistry is widely accepted and incorporated into clinical and educational contexts by evaluating their knowledge, expertise, and confidence in using digital tools.^{3,4}

For three decades, the CAD/CAM application in dentistry has gradually evolved. It can be inlay, onlay, veneer, crown, fixed partial dentures, implant abutments and total-mouth reconstruction. It is known to dentist, dental offices and dental laboratories The dentistry sector is always changing due to digital innovations, thus future dentists need to be properly trained and educated to have the abilities they need. This goal is to evaluate the efficacy, accessibility, and quality of educational programs centered around digital dentistry, namely



CAD-CAM technology. It will investigate how well students and practitioners feel equipped to apply these digital strategies in real-world situations, as well as whether institutions offer enough practical instruction, workshops, or academic information.⁵

Traditional techniques of constructing dental restorations usually included hand craftsmanship, which is time-consuming and frequently inaccurate. CAD-CAM allows dental specialists to use digital imprints and automated production processes, overcoming previous limits. Principle of CAD-CAM: The theory of CAD-CAM in dentistry may be explained in three stages. The first stage includes scanning the dental anatomy to make a digital imprint. In the second stage, the practitioner uses CAD software to plan the repair on a computer, guaranteeing an exact fit and desired appearance. The last stage involves using CAM to construct the repair from a block of ceramic or other materials. Dental students and practitioners may have varying levels of awareness and exposure to CAD-CAM technology.^{6,7}

Dental students and practitioners may have varying levels of awareness and exposure to CAD-CAM technology.⁷

This objective aims to compare their understanding and usage patterns to determine whether students, who are being trained in a more digitalized era, have a greater knowledge advantage over experienced practitioners who may still rely on traditional techniques. Analysing these differences will offer valuable insights into whether additional training is required for practitioners and how dental education can bridge any knowledge gaps between the two groups.

This survey aims to assess the level of awareness about CAD/CAM prostheses among dental practitioners and dental students in Uttarakhand, Uttar Pradesh, and Delhi, India.

2. Objectives

Assessing the current level of awareness regarding CAD-CAM prostheses among dental professionals is essential to understand how familiar both practitioners and students are with this evolving technology. Several factors influence the adoption of CAD-CAM systems in clinical practice, including cost, accessibility, institutional support, academic exposure, and perceived ease of use.

Evaluating the effectiveness of training and education programs is crucial, as well-structured learning opportunities can significantly enhance competence and confidence in using these digital systems.

Moreover, understanding the perceived benefits, provides valuable insight into the hesitations or motivations behind its use.

A comparison of awareness between dental practitioners and students can further reveal important trends, with students often more exposed to the latest theoretical advancements and practitioners offering practical insights from clinical experience, highlighting the need for integrated educational strategies to bridge any knowledge gaps.

3. Methods

A randomised sample of dental professionals, including BDS and MDS students as well as practicing dentists in Delhi, Uttarakhand, and Uttar Pradesh, are to take part in this study.

The primary means for gathering data will be a validated questionnaire that guarantees homogeneity in both language and content. Google Forms was used to conduct the survey in order to make it easy to access and participate.

To assess the participants' understanding, mind-set, and actions about CAD-CAM technology in dentistry, the questionnaire will gather demographics about them.

To guarantee a fair representation of the population, the sampling approach entails the random selection of individuals from the relevant demographic regions.

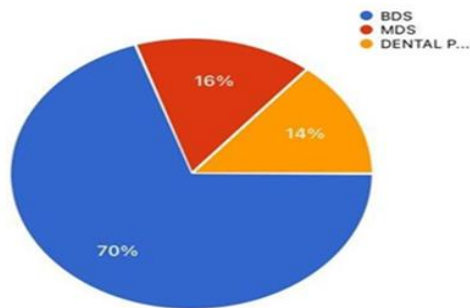
All replies were gathered according to the organized questionnaire's design, which will sustain coherence and clarity.

The survey's data was methodically examined to assess dentistry students' and practitioners' knowledge levels, influencing variables, training experiences, perceived advantages, and difficulties using CAD-CAM technology.



4. Results

The study included a total of 500 participants, with a higher proportion of female respondents (66%) compared to males (34%). This gender distribution reflects the participation pattern within the surveyed population. In terms of professional qualification, the majority of respondents were BDS students (70%), followed by MDS students (16%) and practicing dentists (14%). This composition highlights that a significant portion of the study participants are still in their academic phase, which may influence their exposure and awareness of CAD-CAM technology. The inclusion of dental practitioners alongside students allows for a comparative assessment of knowledge and experience levels across different stages of dental education and practice.

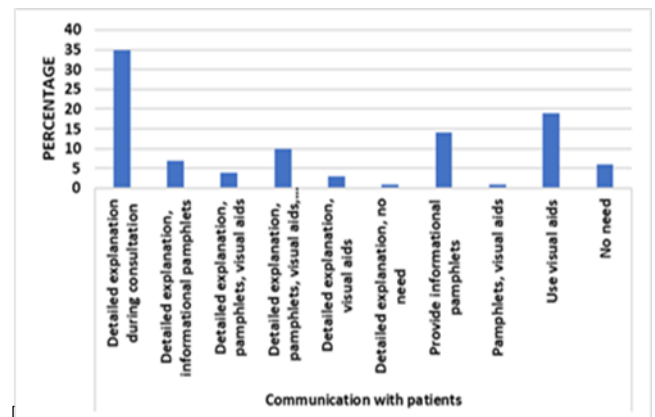


Pie chart 1 professional response

The study included participants from three key regions: Utrakhand, Delhi, and Uttar Pradesh. As illustrated in Figure 1, the majority of respondents (52.1%) were from Utrakhand, followed by 26% from Delhi and 21.9% from Uttar Pradesh. This distribution ensures representation from different geographic areas, allowing for a comparative assessment of awareness and adoption of CAD-CAM technology across various locations. The higher participation from Utrakhand may be attributed to institutional outreach or accessibility of the survey in that region.

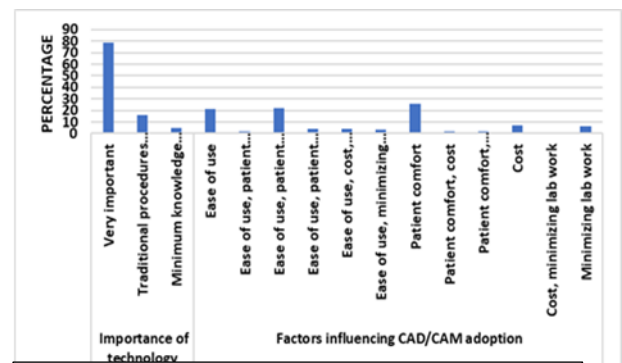
The results of the study provide several important inferences about the awareness, adoption, and attitudes toward CAD/CAM technology among dental practitioners and students. Here’s a breakdown of the key insights:

Effective communication between dental professionals and patients plays a crucial role in ensuring informed decision-making and treatment acceptance. As shown in Bar Graph 1, the most preferred method of communication is providing a detailed explanation during consultation, with the highest percentage of respondents favoring this approach. Other methods, such as using pamphlets, visual aids, or professional



Pie chart 2: Geographic distribution of survey participants

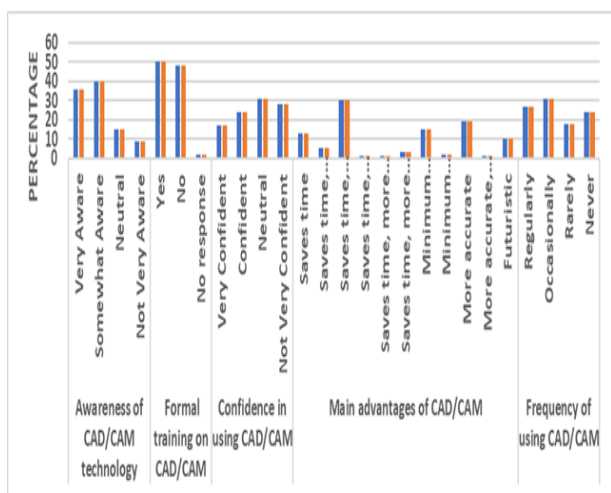
guidance, also contribute to patient understanding, though to a lesser extent. A smaller percentage of respondents indicated that no additional explanation was needed, suggesting that most patients benefit from structured communication methods.



Bar graph 1: Effective communication between



These findings highlight the importance of enhancing patient education through clear verbal explanations and supplementary tools like visual aids and pamphlets. Incorporating digital tools, such as CAD-CAM demonstrations, could further improve patient engagement and understanding of advanced dental treatments.



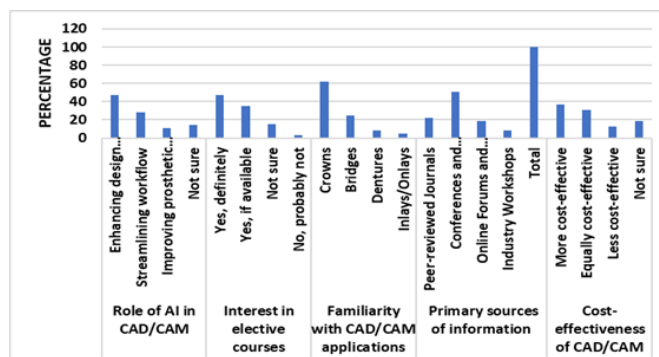
Bar graph: 2 Awareness, Training, Confidence Levels, Perceived Advantages, And Frequency of CAD-CAM Usage Among Participants

This Bar graph 2 presents a detailed breakdown of awareness, training, confidence levels, perceived advantages, and frequency of CAD-CAM usage among participants. A significant proportion of respondents reported being somewhat aware or very aware of CAD-CAM technology, highlighting a moderate to high level of familiarity. However, a relatively lower percentage had received formal training, indicating a gap between awareness and hands-on education.

Regarding confidence in using CAD-CAM, responses varied, with some participants feeling confident or very confident, while others expressed limited confidence, likely due to a lack of practical exposure. The chart also highlights the main advantages of CAD-CAM, with stress-free procedures, minimal errors, and time efficiency being the most commonly recognized benefits.

In terms of frequency of usage, responses ranged from rarely to occasionally, suggesting that while awareness exists, practical application remains limited. This

emphasizes the need for improved training programs and hands-on workshops to enhance the adoption of CAD-CAM technology in routine dental practice.



Bar graph :3 Perspectives on AI, Learning Interests, and Cost-Effectiveness in CAD-CAM

Bar graph 3 provides insights into participants' views on the role of Artificial Intelligence (AI) in CAD-CAM, their interest in elective courses, familiarity with CAD-CAM applications, sources of information, and cost-effectiveness considerations. A notable proportion of respondents acknowledged that AI plays a role in enhancing design accuracy and streamlining workflows, suggesting awareness of its growing influence in digital dentistry.

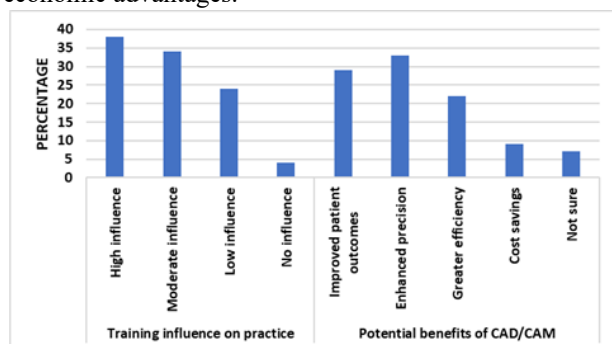
Interest in elective courses related to CAD-CAM varied, with some participants expressing strong interest and others uncertain about pursuing additional education in this field. Familiarity with CAD-CAM applications was reported at different levels, with conferences, hands-on workshops, and peer-reviewed articles being the primary sources of information. Regarding cost-effectiveness, responses indicate mixed opinions, with some considering CAD-CAM more cost-effective in the long run due to reduced material wastage and efficiency, while others perceived it as a high-cost investment with limited accessibility. These findings emphasize the need for increased awareness, structured training, and accessibility to support the adoption of CAD-CAM technology in dental practice.

Impact of Training on Practice and Perceived Benefits of CAD-CAM Bar graph 4 highlights the significance of training in CAD-CAM technology and the potential benefits it offers in clinical practice. A considerable



proportion of respondents reported that training has a high influence or moderate influence on their practice, indicating that hands-on experience and structured education play a crucial role in the successful adoption of CAD-CAM. However, a smaller percentage indicated low or no influence, which may reflect limited exposure to training opportunities.

Regarding the benefits of CAD-CAM, the most frequently cited advantages were enhanced precision, greater efficiency, and improved patient outcomes. A smaller proportion of participants recognized cost savings as a major benefit, while a few remained uncertain about the technology's impact. These findings suggest that while CAD-CAM is widely acknowledged for its precision and efficiency, further education and exposure may be needed to highlight its long-term economic advantages.



Bar 4: Impact of Training on Practice and Perceived Benefits of CAD-CAM

The data presented in illustrates the impact of training on CAD/CAM adoption and its perceived benefits among respondents. The majority reported satisfaction with CAD/CAM, with factors like increased patient expectations, guided treatment, and enhanced digital communication influencing its adoption. Hands-on experience was deemed crucial, with many recognizing its importance for skill development. While moderate to extensive integration of CAD/CAM was observed, confidence levels varied, suggesting a need for enhanced training programs. These findings highlight the necessity of structured education and workshops to bridge the gap between knowledge and practical implementation.

Graph 5 shows that the most significant factor influencing CAD/CAM adoption is the perceived importance of technological knowledge, followed by preference for traditional procedures and the ease of use for practitioners. Minimum knowledge requirements and patient-related factors such as comfort and ease of use also play a role but to a lesser extent. Cost considerations and minimizing laboratory work rank lowest, indicating that clinical familiarity and usability are prioritized over financial aspects.

Future Considerations

- **Interest in Further Learning:** A significant interest in elective courses (82% either definitely interested or interested if available) suggests a strong demand for continued education on CAD/CAM.
- **Integration and Knowledge:** Respondents recognize the importance of integrating CAD/CAM technology into practice, with 66% believing that knowledge of technology is very important.

5. Discussion

The findings of this study underscore a significant awareness of CAD/CAM technology among dental practitioners and students, reflecting its recognition as a transformative tool in modern dentistry. However, the disparity between awareness and practical application reveals critical gaps in training, accessibility, and adoption⁸

While 76% of respondents are aware of CAD/CAM, only half have received formal training, leaving a substantial portion without the knowledge or skills needed for effective use. The lack of confidence in utilizing the technology, with only 17% feeling very confident, and the infrequent use, where nearly one-quarter have never used CAD/CAM, further emphasize the existence of systemic barriers. These challenges are likely influenced by factors such as high costs, limited access to equipment, and insufficient hands-on training opportunities.⁸

Despite these barriers, respondents acknowledged the significant advantages of CAD/CAM technology, particularly in enhancing accuracy, improving efficiency, and reducing treatment turnaround times, which are critical benefits in patient-centred care. The reported satisfaction rate of 65% among users reflects



positive experiences and reinforces the potential for broader adoption if training and access are improved.⁹

Moreover, the findings highlight the impact of structured education, with 72% of respondents recognizing that training has a moderate to high influence on their practice. The overwhelming interest in further education, with 82% expressing a desire to participate in elective courses, demonstrates a strong demand for more accessible and comprehensive learning pathways.¹⁰

Furthermore, the study highlights a clear trend in the importance of CAD/CAM integration into clinical practice, with 66% of respondents emphasizing that knowledge of this technology is crucial. This reflects a growing recognition of CAD/CAM as a cornerstone of modern dental workflows, offering improved accuracy and efficiency that align with the evolving demands of patient care. The respondents' emphasis on quicker treatment turnaround as a primary factor driving adoption underscores the practical value of CAD/CAM in enhancing service delivery and patient satisfaction.¹¹

Additionally, the futuristic potential of CAD/CAM technology acknowledged by 10% of respondents suggests an awareness of its capacity to shape the future of dentistry through innovations such as digital diagnostics, advanced prosthodontic designs, and minimally invasive procedures.¹²

The findings of our study align with the British Journal survey, where despite high interest in CAD/CAM, actual clinical integration remains low due to barriers such as high costs, limited training, and lack of perceived benefit over traditional methods. In our context, while financial investment remains a concern, the predominant challenge lies in insufficient hands-on exposure during academic training, particularly for students. Both studies highlight that existing users report positive clinical outcomes—including improved accuracy, efficiency, and material choices—indicating that broader adoption is less a matter of technological skepticism and more a result of accessibility and training limitations. This convergence underscores the need for strategic integration of CAD/CAM into dental curricula and continuing education, which could bridge the gap between awareness and practical use, ultimately aligning Indian dental practice with global digital dentistry trends.¹³

Both the Robinson and McGrail review on CAM disclosure and our CAD/CAM study highlight that awareness alone does not ensure integration into practice. In CAM, non-disclosure often results from perceived disinterest or anticipated negative responses, while in CAD/CAM, underuse stems from insufficient training and systemic barriers. In both cases, proactive engagement and open communication are essential to normalise adoption and embed these approaches into routine clinical care.¹⁴

This study highlights high awareness but low adoption of CAD/CAM among dental students and practitioners due to limited training and infrastructure, while Saponaro et al. report high patient satisfaction—70% rating digital dentures better than conventional ones—when CAD/CAM is implemented. Together, they show that patient acceptance is strong, but practitioner preparedness and access remain the main barriers to wider clinical uses.¹⁵

References

1. Orsini G., Tosco V., Monterubbianesi R., Orilisi G., Putignano A. A New Era in Restorative Dentistry. In: Longhi S., Moneriù A., Freddi A., Aquilanti L., Ceravolo M.G., Carnevali O., Giordano M., Moroncini G., editors. *The First Outstanding 50 Years of "Università Politecnica Delle Marche": Research Achievements in Life Sciences*. Springer International Publishing; Cham, Switzerland: 2020. pp. 319–334.
2. Tapie L., Lebon N., Mawussi B., Fron Chabouis H., Duret F., Attal J.P. Understanding Dental CAD/CAM for Restorations—the Digital Workflow from a Mechanical Engineering Viewpoint. *Int. J. Comput. Dent.* 2015; 18:21–44.
3. Swapnali Mhatre, Prachi Ghol, Appooja Kakade /Evolution of intraoral scanners in dentistry: an overview / *European Chemical Bulletin*/ Oct 2023;12(7): [4267-4276]
4. Rexhepi I, Santilli M, D'Addazio G, Tafuri G, Manciocchi E, Caputi S, Sinjari B. Clinical Applications and Mechanical Properties of CAD-CAM Materials in Restorative and Prosthetic Dentistry: A Systematic Review. *J Funct Biomater.* 2023 Aug 17;14(8):431.
5. Suganna M, Kausher H, Tarek Ahmed S, Sultan Alharbi H, Faraj Alsubaie B, Ds A, Haleem S,



- Meer Rownaq Ali AB. Contemporary Evidence of CAD-CAM in Dentistry: A Systematic Review. *Cureus*. 2022 Nov 20;14(11): e31687.
6. Schaefer O, Schmidt M, Goebel R, Kuepper H. Qualitative and quantitative three-dimensional accuracy of a single tooth captured by elastomeric impression materials: An in vitro study. *J Prosthet Dent*. 2012; Sep;108(3):165-72
 7. Choukse V, Kunturkar A, Nirmal Aidasani A, et al. (June 13, 2023) Survey of Indian Dental Professionals Regarding the Use of Computer-Aided Design/Computer-Aided Manufacture (CAD/CAM) Technology.
 8. Maiti N, Mahapatra N, Patel D, et al. Application of CAD-CAM in Dentistry. *Bioinformation*. 2024;20(5):547-550
 9. Tinschert J, Natt G, Hassenpflug S, Spiekermann H. Status of current CAD/CAM technology in dental medicine. *International journal of computerized dentistry*. 2004 Jan 1;7(1):25-45.
 10. Alghazzawi TF. Advancements in CAD/CAM technology: Options for practical implementation. *Journal of prosthodontic research*. 2016 Apr 1;60(2):72-84.
 11. Sushmita V. Palanisamy Chethan Hegde. Awareness Among Dental Undergraduate Students Regarding CAD/CAM Technology—A Survey Report. *Health Allied Sci NU* 2019; 9:57–63
 12. Jaykumar Gade, Karan Jaiswal, Megha Agrawal, Anand Agarkar, Anil Ingole, Sayali Dandekar, Knowledge and Awareness amongst Dental Undergraduate Students Regarding CAD-CAM Technology in Central India: A Cross Sectional Survey, *J Res Med Dent Sci*, 2021, 9(10):8-11
 13. Tran D, Nesbit M, Petridis H. Survey of UK dentists regarding the use of CAD/CAM technology. *British dental journal*. 2016 Nov 18;221(10):639-44.
 14. Robinson A, McGrail MR. Disclosure of CAM use to medical practitioners: a review of qualitative and quantitative studies. *Complementary therapies in medicine*. 2004 Jun 1;12(2-3):90-8.
 15. Saponaro PC, Yilmaz B, Johnston W, Heshmati RH, McGlumphy EA. Evaluation of patient experience and satisfaction with CAD-CAM-fabricated complete dentures: A retrospective survey study. *The Journal of prosthetic dentistry*. 2016 Oct 1;116(4):524-8.