

A Survey on Awareness, Attitude, and Knowledge of Computer-aided Design/Computer-Aided Manufacturing (CAD/CAM) Role in Dentistry among Dental Undergraduate Students

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Abstract

Background: This study evaluates the awareness, knowledge, and perceptions of dental undergraduate students regarding computer-aided design/computer-aided manufacturing (CAD/CAM) technology in dentistry within East and West Godavari districts, Andhra Pradesh, India. **Methodology:** A cross-sectional survey was conducted using a structured questionnaire distributed to dental students within dental colleges of East and West Godavari districts, Andhra Pradesh, India, yielding 323 responses. The questionnaire assessed demographics for awareness, and attitudes toward CAD/CAM technology. **Results:** Findings indicate that 50.2% of participants were familiar with CAD/CAM, but only 29.7% had practical exposure, highlighting a gap between theory and practice. Most respondents (71.6%) recognized its primary use in prosthodontics, and 76.2% acknowledged its functionalities, including intraoral scanning. However, 55.1% perceived CAD/CAM as more costly than traditional methods. High interest in CAD/CAM education (80.6%) was noted, though only 30.7% attended related workshops. **Conclusion:** The study reveals significant interest in CAD/CAM technology among dental students, alongside a need for enhanced practical training and educational resources. Addressing this gap in curricula will better prepare future practitioners for advancements in dental practice.

Keywords: Computer-aided design/computer-aided manufacturing technology, Dental education, Digital dentistry, Educational resources, Undergraduate students.

INTRODUCTION

Computer-aided design (CAD) and computer-aided manufacturing (CAM) have become an increasingly essential part of dentistry over the past years. CAD–CAM technologies are now widely used in both dental laboratories and offices, offering advanced applications across different dental specialties.^[1]

CAD/CAM was first introduced into dentistry in the 1970s with Duret. Duret took the digital impression of an abutment tooth after cutting, and then with the help of that impression he fabricated a crown using the numerically controlled machine.^[2,3]

CAD/CAM technology was developed to address three key challenges in dentistry. The first challenge was to ensure that restorations, particularly for posterior teeth, had sufficient strength. The second challenge was to create restorations that closely mimicked the natural appearance of teeth. The third challenge was to streamline the process of tooth restoration, making it quicker, easier, and more precise. In some instances, CAD/CAM technology allows for same-day restorations, providing significant convenience for patients.^[1,2]

CAD/CAM systems are increasingly prevalent in dental offices, with over 30,000 dentists worldwide utilizing scanning and milling machines, including 10,000 in the United States and Canada. These systems have enabled the completion of over 15 million chairside economical restoration of esthetic ceramics. Despite these advancements, many emerging dentists are still not fully aware of the latest technologies. In contrast, today's students, who are accustomed to a world of digital innovation and interactive technology, expect their education to incorporate cutting-edge tools and techniques.^[2,4]

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It is of interest to determine if the undergraduate curriculum has kept pace with the recent innovations in digital dental appliance production currently being employed by increasing numbers of dental laboratories. This survey aims to assess the level of awareness, attitude, and knowledge of CAD/CAM role in dentistry among dental undergraduate students of various dental colleges in East and West Godavari districts of Andhra Pradesh, India.

METHODOLOGY

A cross-sectional study was conducted among dental undergraduate students of colleges in the East and West Godavari districts of Andhra Pradesh, India. The questionnaire was designed to assess the knowledge, awareness, and perception regarding CAD and CAM technology among dental undergraduate students. The questionnaire was developed through a systematic process, involving a thorough review of existing literature.^[2,5-8] As a result, only minor modifications were made, keeping it largely consistent with previously used questionnaires in the literature and so a questionnaire with a total of 31 questions including demographic details which are open and multiple-choice types was designed. It was circulated using Google Forms for ease of access among dental undergraduate students of various dental colleges in East and West Godavari districts of Andhra Pradesh, India, and the responses were recorded.

RESULTS

The survey conducted to assess the awareness, attitude, and knowledge of CAD/CAM in dentistry among dental undergraduate students yielded a total of 323 responses which are enlisted in Table 1. The participants primarily consisted of 240 females and 83 males, aged between 19 and 26 years. The distribution of respondents by academic year included 61 1st-year, 119 2nd-year, 53 3rd-year, 31 4th-year students, and 59 interns, indicating a diverse representation across the undergraduate dental program.

Awareness of CAD/CAM was mixed, with 50.2% reporting knowledge, whereas 29.4% had none, and 20.4% had some familiarity. Only 29.7% had seen a CAD/CAM unit, indicating a gap between knowledge and practical exposure. Most (65.3%) correctly identified CAD/CAM, but misconceptions existed.

Students believed CAD/CAM is mainly used in prosthodontics (71.6%), whereas recognizing its processes such as intraoral scanning and crown fabrication (76.2%). System preferences showed that 44.3% acknowledged its use in both in-office and laboratory settings, and many were aware of its material milling capabilities.

The advantages of CAD/CAM were recognized by 72.7% as it improves accuracy and eliminates issues with conventional impressions. While 31.2% thought intraoral and model

scanning was equally accurate, 70.6% favored intraoral scanning for its benefits in comfort and efficiency. Financial concerns were notable, with 55.1% viewing CAD/CAM as costlier than traditional methods.

Despite challenges such as a learning curve (acknowledged by 35.6%), 56.7% believed CAD/CAM enhances crown precision. Interest in CAD/CAM was high, with 80.6% wanting to learn more, and 63.8% willing to incorporate it into their future practices. However, a lack of exposure to lectures or workshops was evident, with 69.3% having not participated in such educational opportunities.

DISCUSSION

A CAD/CAM system consists of a process chain which includes scanning, designing, and milling. The scanning device converts the shape of the prepared teeth into voxels (3-D units of information). The operator designs a restoration shape using the computer generating a tool path, used by the milling device to create the shape from a restorative material.^[9] Till date, CAD/CAM technology has been used in the production of various types of restorations including inlay, onlay, crowns, veneers, multi-unit (FPD) and implants, abutments full mouth restorations, and complete dentures and also used in orthodontics as Invisalign aligners, orthodontics splints, fabrication of removable denture and maxillofacial prosthesis, guided implant surgery, orthodontic surgery and guided bone regenerations.^[8]

Dentistry has advanced from various earlier treatments such as crude restorations made of wires and wood to the new advancing world of digital dentistry. Digitization using CAD/CAM technology has become popular and well-liked over the past three decades. CAD/CAM technology is one of them that has resulted in the precise and accurate fabrication of prostheses with fewer chances of errors in the patient's mouth and required adjustments are done. This is advantageous and important for both the dentist and the patients. Hence, it had overcome the disadvantages of the conventional methods, especially in terms of quality, labor, and duration.^[5,6]

The results of this survey on CAD/CAM technology awareness among dental undergraduate students highlight significant trends in knowledge, exposure, and perceptions regarding this innovative approach in dentistry. With 50.2% of respondents indicating some level of familiarity with CAD/CAM, it is clear that a foundational awareness exists. However, the fact that only 29.7% have seen a CAD/CAM unit suggests a disconnect between theoretical knowledge and practical exposure, emphasizing the need for more hands-on training in dental curricula.

The strong recognition of CAD/CAM by 65.3% of participants indicates a good understanding of its definition. However, the prevalence of misconceptions – such as alternative interpretations – calls for enhanced educational efforts to

Table 1: Questionnaire and comparison of responses regarding awareness, attitude, and knowledge of CAD/CAM role in dentistry among dental undergraduate students of colleges in East and West Godavari districts of Andhra Pradesh, India

S. No.	Questions	Responses	%
01.	Age	10–20 years	55.1
		20–30 years	44.89
		30–40 years	0
02.	Gender	Male	25.8
		Female	74.2
03.	Academic year	I year	18.9
		II year	36.8
		III year	16.4
		IV year	9.6
		Intern	18.3
04.	Do you have any idea regarding CAD–CAM in dentistry?	Yes	50.2
		No	29.4
		Somewhat	20.4
05.	Have you ever seen a CAD–CAM unit?	Yes	70.3
		No	29.7
06.	CAD–CAM stands for	Computer-aided dentistry and computer-aided medicine	19.8
		Computer-aided designing and computer-aided manufacturing	65.3
		Computer-analyzed dentistry and computer-analyzed medicine	8.7
		Computer-analyzed designing and computer-analyzed manufacturing	6.2
07.	Which department in dentistry do you think utilizes CAD–CAM? (you can select multiple options)	Prosthodontics	71.5
		Endodontics	23.2
		Orthodontics	19.2
		Periodontics	8
		Pedodontics	10.8
		Oral medicine and radiology	8.4
		Oral pathology	3.1
		Oral surgery	8
		Public health dentistry	1.9
		All the above	19.8
08.	CAD–CAM includes	Intraoral scanning	9.6
		Crown designing	6.8
		Crown fabrication	6.5
		Shade matching	0.9
		All of the above	76.2
09.	CAD–CAM technology is used in the fabrication of (you can select multiple options)	Tooth supported prosthesis	15.2
		Implant-supported prosthesis	13.3
		Removable dentures	6.5
		All of the above	76.2
10.	CAD–CAM can be used in	In office system	5.6
		Laboratory-based system	26.9
		Both	44.3
11.	CAD–CAM helps in the milling of	No idea	23.2
		Zirconia	27.9
		Metal	15.5
		Wax	4.6
		Peek	1.9
		All the above	31.6
12.	CAM software includes	No idea	32.8
		Additive technology	14.6
		Subtractive technology	5.9
		Both	44.9
		No idea	34.7

(Contd...)

Table 1: (Continued)

S. No.	Questions	Responses	%
13.	Do you aware of different methods of scanning in CAD–CAM?	Yes	67.8
		No	32.2
14.	CAD–CAM helps in (you can select multiple options)	Eliminates the problem associated with conventional impression-making	17
		Data transfer, communication, and storage	10.2
		Increases the accuracy and precision of the treatment	14.9
		All of the above	72.8
15.	Did CAD–CAM increases work efficiency compared to conventional methods?	Increases work efficiency	47.1
		Decreases work efficiency	12.7
		No difference	3.7
		No idea	36.5
16.	What is more accurate?	Intraoral scanning	29.1
		Model scanning	7.4
		Both	31.3
		No idea	32.2
17.	Accuracy of impressions more with intraoral scanning?	True	55.4
		False	6.8
		No idea	37.8
18.	Intraoral scanning has advantages over conventional impressions such as (you can select multiple options)	Accuracy	18.6
		Patient comfort	15.5
		Less time	12.4
		No idea	70.6
19.	Which is more costly?	CAD CAM technique	55.1
		Conventional technique	8.4
		No idea	36.5
20.	Disadvantages of CAD–CAM	Learning curve	6.5
		Cost	26.3
		Both	35.6
		No idea	31.6
21.	Is CAD–CAM technology help in improving the precision and accuracy of crowns?	Improves	56.7
		Does not improve	8.7
		No idea	34.7
22.	What do you prefer?	CAD CAM technique	51.1
		Conventional technique	11.1
		No idea	37.8
23.	Do you think CAD–CAM plays a big role in the scope of dentistry?	Yes	56.3
		No	7.1
		May be	36.5
24.	Did you attend any lectures/workshops regarding CAD–CAM?	Yes	30.7
		No	69.3
25.	Do you think that CAD–CAM revolutionized dentistry?	Yes	51.7
		No	10.2
		May be	38.1
26.	Do you think learning CAD–CAM from the undergraduate level is essential?	Yes	57.6
		No	12.1
		May be	30.3
27.	Are you interested in learning CAD–CAM?	Yes	80.5
		No	19.5
28.	Would you be interested in incorporating CAD–CAM as part of your workflow in future practice?	Yes	63.8
		No	9.6
		May be	26.6

CAD-CAM: Computer-aided design/computer-aided manufacturing

clarify what CAD/CAM entails. The overwhelming belief (71.6%) that CAD/CAM is primarily used in prosthodontics aligns with its most common applications in restorative dentistry, yet it also underscores the necessity to educate students about its broader applications across various dental specialties.

A notable 76.2% of respondents recognized the comprehensive functions of CAD/CAM, including intraoral scanning and crown fabrication, which are critical for modern dental practices. This understanding reflects the increasing integration of technology in dental education; however, there remains a significant opportunity to enhance knowledge regarding its functionalities and benefits. The fact that 72.7% believe CAD/CAM eliminates issues associated with traditional impression techniques is promising, as it underscores the perceived advantages of adopting this technology, such as improved accuracy and patient comfort.

Despite the positive perceptions, concerns regarding cost – highlighted by 55.1% of respondents who view CAD/CAM as more expensive than conventional methods – may hinder its adoption in clinical settings. Addressing these financial considerations through education on long-term benefits and efficiencies could encourage more widespread integration of CAD/CAM technologies in dental practices.

The high interest in learning about CAD/CAM (80.6%) and the willingness to incorporate it into future practices (63.8%) are encouraging indicators of students' readiness to embrace technological advancements in dentistry. However, the low attendance at relevant workshops (30.7%) signals a gap in available educational resources. To capitalize on this enthusiasm, dental programs should prioritize offering more workshops, seminars, and hands-on training sessions focused on CAD/CAM technologies.

CONCLUSION

The survey highlights strong interest and recognition of CAD/CAM technology's relevance in modern dentistry, yet there is a clear need for increased practical exposure and education to bridge the gap between theory and application. Based on the study results, undergraduate students demonstrate awareness of digital technologies but lack the necessary clinical knowledge, which can only be gained through hands-on experience. Addressing misconceptions, improving training opportunities, and updating the curriculum regularly will better equip future dental practitioners for the evolving field.

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