

ORIGINAL ARTICLE

APPLICATIONS OF CAD/CAM TECHNOLOGY IN DENTISTRY

Răzvan Eugen Ghiță^{1,*}, Andrei Stanciu², Sanda Mihaela Popescu¹, Antonia Samia Khaddour¹, Veronica Mercuț³, Monica Scriciu³, Monica Mihaela Iacov-Crăițoiu³, Emma Cristina Drăghici¹, Melania Olimpia Cojocaru¹

¹ Department of Oral Rehabilitation, University of Medicine and Pharmacy of Craiova, 200349 Craiova, Romania

² DDS, Private Practice Craiova, Romania

³ Department of Prosthetics Dentistry, University of Medicine and Pharmacy of Craiova, 200349 Craiova, Romania

All authors contributed equally to this work.

* Corresponding author:
Răzvan Eugen Ghiță,
Department of Oral Rehabilitation, University of Medicine and Pharmacy of Craiova, 200349 Craiova, Romania
Email:
razvan.ghizza@yahoo.com



Abstract: Digital dentistry has been introduced for over 40 years, but their overspread use has become available in the last two decades, after year 2000. First to introduce it in dentistry was a dentist, but the widespread of the digital dentistry was carried out mostly by dental technicians. In Romania, digital dentistry had become available with state funding projects for the dental field. Objective The aim of the study was a broader assessment of the use of CAD/CAM systems in dental practices and dental technology laboratories. *Materials and method.* The study consisted in a survey based on a questionnaire, distributed in electronic form, applied to two branches of dentistry, respectively, for dentists and dental technicians. The study was attended by dentists and dental technicians, from the urban environment. Results were analyzed using statistical methods with Microsoft Excel. *Results.* The results of the present study showed a high degree of knowledge regarding CAD/CAM technology, as most of the participants were aware of the introduction and use of digital technology in dentistry. Majority of dental technicians have introduced and have worked with CAD_CAM systems, comparative with dentists, which only a third part worked usually with these technologies. *Conclusions.* Even though digital dentistry is a modern technology with advantages, there are still some concerns from dentists and technicians about the quality and costs of CAD/CAM restorations.

Keywords: CAD/CAM, digital technology, dentists, dental technicians, questionnaire.

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1. Introduction

In the last 20 years, computer-aided design (CAD)/computer-aided manufacturing (CAM) has become increasingly used in all medical fields, including dentistry [1]. CAD/CAM technology is used to manufacture inlays, onlays, veneers, crowns, fixed partial dentures, implant abutments, in orthodontics and even in complex oral rehabilitation [2]. Modern dental practice involves an increasingly frequent application of new technologies, which present numerous advantages that facilitate the work of the dentist, but also from the point of view of the patients, who are becoming more and more demanding in terms of aesthetic requirements, and with the clearly expressed desire to spend as little time as possible in the dental office [3].

The computer, as a means of interactive communication, has a greater role in modern dental prosthetics in terms of practice in the dental office, but also in dental technical laboratories. The use of computers in dental therapy is a challenge for enthusiasts and visionaries who have developed an entirely new field: computerized dentistry. CAD/CAM systems represent the pinnacle of computer technology with many realized and potential applications in dentistry [4].

According to the production methods, CAD/CAM systems can be classified into three categories [5]: dental office system, laboratory system and centralized production. With the laboratory system and the centralized production system, the responsibility of producing the dental restoration is delegated to the dental technician with the help of the CAD/CAM milling unit.

Older CAD/CAM systems required a minimum of two visits to the dental office to complete the dental restoration, whereas the in-office system allows the dentist to control the entire process, starting with taking a digital impression of the prepared tooth(s) and then designing and manufacturing the restoration their dental. Finally, the final restoration is delivered at the same visit. In general, CAD/CAM systems involve three elements. The first element is a digitizer/scanner tool that transforms the geometry into digital data that can be processed by the computer. The second element is the Software that processes the data obtained from the digital scanner. The third part of the CAD/CAM system is a milling machine that receives the information from the Software to produce a dental restoration with specific features and design. To date, CAD/CAM technology has been implemented to produce various types of dental restorations, including inlays, onlays, crowns, veneers, fixed partial dentures, and implant abutments [6].

In digital denture manufacturing workflow, it has been highlighted that different types of dental CAD software can affect the quality of dentures [7].

Standards for dental CAD software released by various manufacturers are still ambiguous as to what criteria dental staff should consider when purchasing such software. Moreover, the information required by different dental personnel remains insufficient for the development and advancement of dental CAD software [8].

By now, CAD/CAM technology has become an essential part of modern dentistry. It can be speculated that this technology will change the shape of future dental practice. However, research investigating the current place of CAD/CAM technology among practicing dentists worldwide is still scarce. What is the attitude of dentists towards this technology? Are they well trained and properly educated to provide such dental services? What about the current nature of dentists' practice in providing CAD/CAM dental restorations? All these questions still do not have clear answers [6]. The present study aimed at a wider evaluation of the use of these systems in dental practices and dental technology laboratories.

2. Materials and method

The studied material was represented by the answers given by the study participants, a comparison was made between the opinions of dentists and those of dental technicians. The following parameters were used: age, workplace, knowledge of CAD/CAM systems, use of CAD/CAM system, tendency to use CAD/CAM systems by certain dental branches, results of CAD/CAM system, results of doctors and technicians, the evaluation of the CAD/CAM system. The study was approved by the University and Scientific Ethics and Deontology Commission of the University of Medicine and Pharmacy of Craiova, respecting the Helsinki 1995 norms, opinion No. 197/24.11.2021.

The research method consisted of conducting a survey based on a questionnaire, distributed in electronic form, applied to two

branches of dentistry, respectively, for dentists and dental technicians. At the beginning of the questionnaire, the purpose of completing the form was stated, participation in the study was optional, and filling in personal data was not necessary, the questionnaire remained anonymous. The electronic format of the questionnaire was created using Google Forms and distributed as a URL. The form was distributed online, using a social media application, over the course of 4 months, from December 2021 to March 2022. The questionnaire allowed each participant to complete the next question only after ticking the answer for the previous question, thus ensuring that all the questions provided will be answered.

Structurally, the questionnaire included 16 questions. The first 2 questions had in mind the collection of information on the basis of which the professional variables of the study group were defined: age and place of work. The second part of the questionnaire included 14 simple and multiple-choice closed questions, related to: knowledge about CAD/CAM systems, use of CAD/CAM systems, tendency to use CAD/CAM systems by certain industries, results of CAD/CAM systems, physician and technician outcomes, CAD/CAM system evaluation.

3. Results

A number of 105 dentists and 52 dental technicians from the Oltenia area responded to the questionnaire. Regarding the age groups of the interviewed dentists, most dentists were between 20 and 40 years old (61.9%), followed

by the 40-55 (31.4%), and the majority of dental technicians were aged between 20 and 40 (73.1%), followed by the 40-55 category (21.2%) (Figure 1).

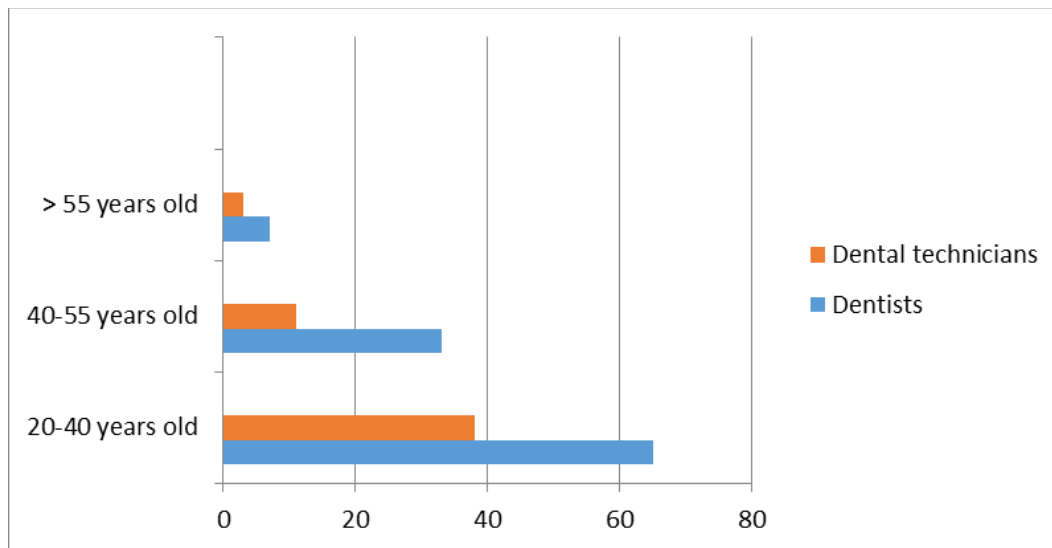


Figure 1. Distribution of study participants in relation to their age.

Regarding the place of work of the interviewed dentists, the majority worked in the private sector (62.9%), then there were those who worked both in the private system and in the state system (30.5%), while very few (6.7%) worked in the public system. Regarding the form of employment of the interviewed

dental technicians, the majority of dental technicians worked as employees with an employment contract (51.9%), then there were those who worked in collaboration (30.8%), the lowest percentage being of those who worked in their own laboratory (23.1%) (Figure 2).

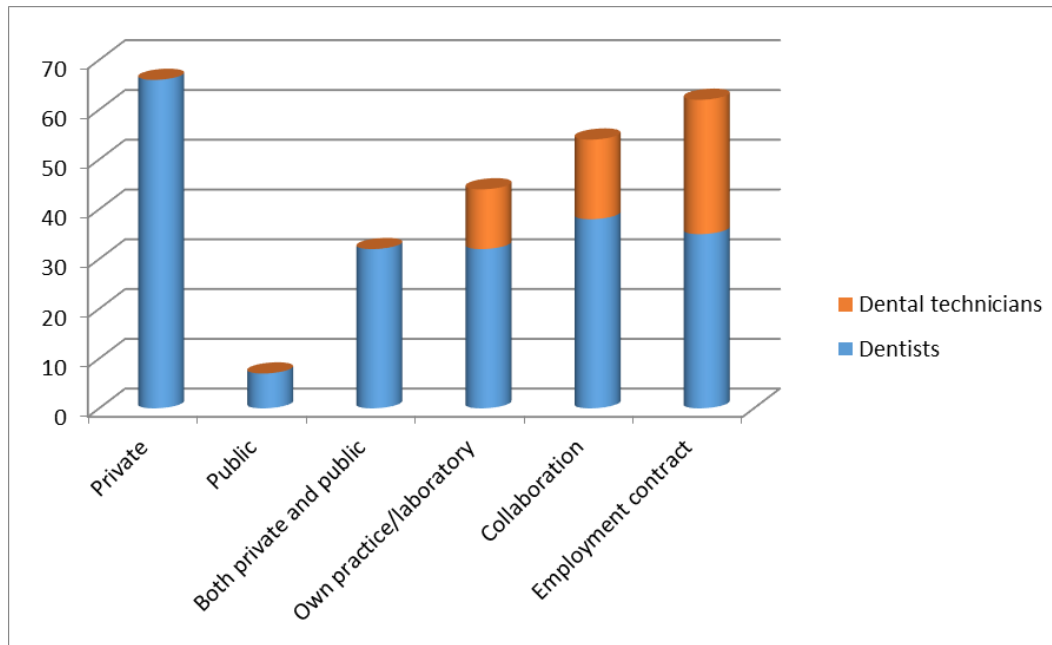


Figure 2. Distribution of study participants in relation to their workplace/form of employment.

Regarding the familiarity of interviewed doctors and dental technicians with CAD/CAM systems, most doctors (79%) and dental technicians (67.3%) are familiar with this concept, most dentists (50.5%) and the

majority of dental technicians (53.8%) used these systems and the majority of dentists (72.38%) and dental technicians (67.3%) expressed their desire to use CAD/CAM systems in the future (Table 1).

Table 1. The answer of the study participants to questions no. 3-9.

Question no.	Dentists		Dental technicians	
	Yes	No	Yes	No
3. Are you familiar with CAD/CAM technology?	83 (79%)	22 (21%)	35 (67,3%)	17 (32,69%)
4. Have you used CAD/CAM technology to date?	53 (50,5%)	52 (49,5%)	28 (53,8%)	24 (46,2%)
5. If you haven't used CAD/CAM technology yet, are you considering using it in the future?	76 (72,38%)	29 (27,61%)	35 (67,3%)	17 (32,69%)
6. Have you used CAD/CAM technology for prosthetic purposes?	57 (54,3%)	48 (45,7%)	30 (57,70%)	22 (42,30%)
7. Have you used CAD/CAM technology for a purpose other than prosthetics?	23 (21,9%)	83 (79,1%)	6 (11,53%)	46 (88,46%)
8. Do you think that using CAD/CAM systems improves dental services?	95 (90,47%)	10 (9,52%)	44 (84,61)	8 (15,38)
9. Do you think that in the future the CAD/CAM system can replace conventional methods?	83 (79%)	22 (21%)	38 (73,07%)	14 (26,92%)

The vast majority of dentists, as well as the vast majority of dental technicians, consider the use of CAD/CAM systems an improvement in dental services and believe that in the future the CAD/CAM system can replace conventional methods (Table 1).

Regarding the performance of CAD/CAM systems, the majority of dentists and dental technicians rated it as very good in terms of aesthetics, durability and value for money (Figure 3).

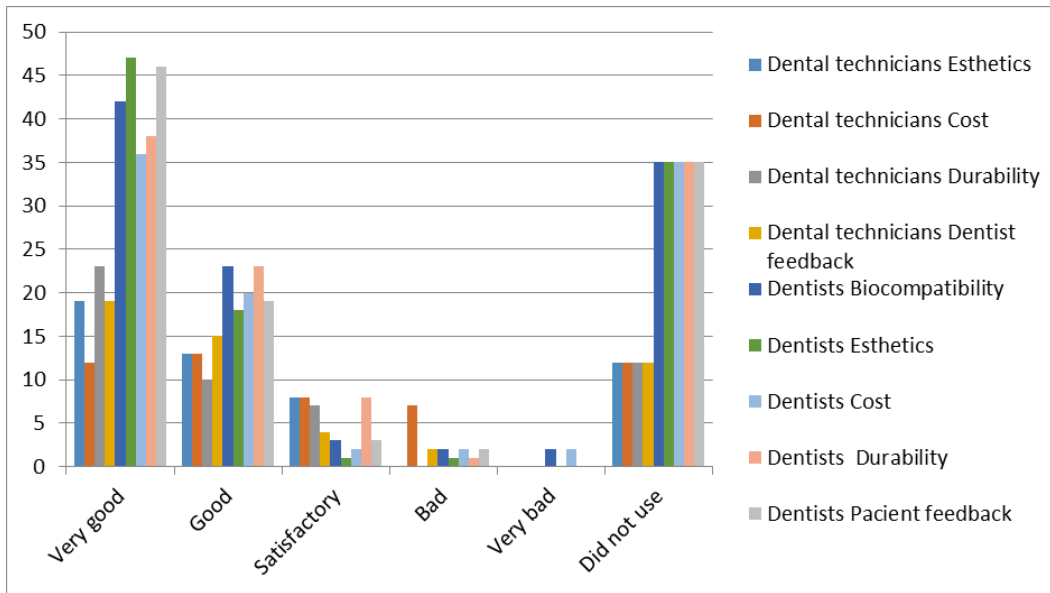


Figure 3. Evaluation of CAD/CAM system performance by study participants.

Regarding the type of system used, the majority of dental technicians used the Exocad

system, followed by the VHF system (Figure 4).

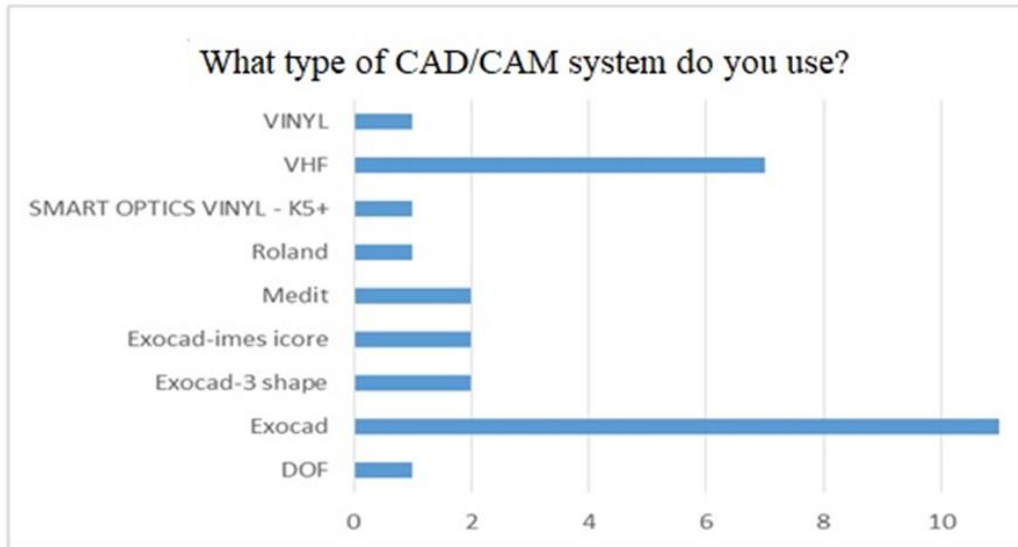


Figure 4. The CAD/CAM system most frequently used by dental technicians.

4. Discussions

Currently, almost every branch of dentistry uses CAD/CAM technology, in the case of maxillofacial surgical prosthetics [9], in the manufacturing of aligners and brackets in orthodontics [10] and up to the manufacture of removable dentures, dental bridges and crowns dental [11,12]. The literature also shows that CAD/CAM technology allows the use of new materials for prosthetic restorations while maintaining quality control of the final prosthetic parts. All these benefits of CAD/CAM technology are expressed in the form of patient satisfaction and long-term reliability of ceramic and composite restorations [13,14].

Despite the major role of CAD/CAM technology in modern dental practice, little information is available on the current practice and attitudes of dentists regarding this

innovative technology [6], questionnaires being undoubtedly one of the most important sources of data in any research project [15].

Most of the survey respondents stated that they are familiar with CAD/CAM systems and have used these systems. Similar results were also reported by studies by Blackwell et al. [16] and Krastev T et al. [17], where about half of the respondents were using CAD/CAD systems in their current practice.

It should be noted, however, that our study shows that dental technicians assimilated this technology much faster compared to dentists, one third of whom stated that they still do not use it in the office. This can be explained by the much greater proximity to the industry of dental laboratories, where digitization has gained considerable momentum in the last decade, compared to dental practices. Thus, in a study carried out in the community of dentists in the UK, Tran et al. showed that less than half

of the respondents to their study used CAD/CAM systems in their practice, demonstrating that CAD/CAM technology is still relatively new to the dental world for most practitioners [18]. In the study conducted, the majority of respondents who did not already use a CAD/CAM system

stated that they seriously consider using CAD/CAM systems in the future, a result also confirmed by the similar study conducted by Mandar et al. [19].

In the present study, the majority of respondents evaluated the aesthetics, durability and value for money aspects of CAD/CAM prosthetics as "very good". Previous studies have reported that the esthetic results and marginal fit of dentures can vary depending on the dental CAD software used in the design process [20].

Similar results were also reported by Nassani et al. [6] in a study where the majority of those who used CAD/CAM systems declared themselves satisfied with them and were willing to recommend them to other

practitioners. In contrast, the study by Tran et al. [18] reported the aesthetics of dentures made by CAD/CAM technology as unsatisfactory.

5. Conclusions

Digital workflow integration in dental practices has streamlined and improved various clinical and laboratory processes. This transformation addressed several limitations associated with conventional procedures, particularly in terms of quality, labor, and time efficiency.

The results of the present study showed a high degree of knowledge regarding CAD/CAM technology, as most of the participants were aware of the introduction and use of digital technology in dentistry.

However, although CAD/CAM technology can be used to create accurate and efficient dental components, there are still some concerns from dentists and technicians about the quality and costs of CAD/CAM restorations.

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Author contributions

All authors read and approved the final manuscript. All authors have equally contributed to this work.

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Conflict of interest statement

The authors declare no conflicts of interest concerning this study.

Data availability statement

Will be provided on request.

Ethics statement

Approved by the Scientific Ethics and Deontology Commission of UMF Craiova (no. 197/24.11.2021).

ORCID

Sanda Mihaela Popescu: <https://orcid.org/0000-0003-3011-6322>

Antonia Sama Khaddour: <https://orcid.org/0009-0000-1672-9734>

Veronica Mercuț: <https://orcid.org/0000-0003-3573-7128>

Monica Scriciu: <https://orcid.org/0000-0003-0696-7100>

Monica Mihaela Iacov-Crăițoiu: <https://orcid.org/0000-0003-4998-8198>

Melania Olimpia Cojocaru: <https://orcid.org/0000-0002-8975-7485>

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