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Digitalization in Prosthodontics

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ABSTRACT
The advent of digital radiography, as well as the first iterations of intraoral scanning and computerassisted design and computer-assisted manufacturing (CAD/CAM) crowns, sparked widespread use of digital technology in dentistry in the early nineties. Digitisation and innovation have infinite potential in prosthodontics, whether in clinic or laboratory processes. New digital devices and processing software, as well as appealing materials and robust manufacturing procedures, are significantly changing dentistry. Today, a growing number of dental clinics and labs see the advantages of becoming digital. A diverse range of digital solutions is possible, including Computer-Aided Design-Computer Assisted Manufacturing (CAD-CAM) technology, rapid prototyping, stereolithography, the CEREC system, and numerous others that are being investigated. The merits and hurdles to digital technology implementation in prosthodontics will be discussed in this review paper. We will also discuss the influence of digital technology on dental learning and its prospects in digital dental care.
Keywords: CAD-CAM technology, Rapid Prototyping, Stereolithography, CEREC system.

I. CHAPTER 1 - INTRODUCTION

Digitalization has become an integral aspect of modern prosthodontics, with the likelihood that most treatments will be performed digitally in the coming years. Digital dentistry offers the effective, quick, accurate, and error-free manufacture of fixed prosthodontics devices. The emergence of digital radiography, as well as the first iterations of intraoral scanning and computerassisted design and computer-assisted manufacturing (CAD/CAM) crowns, sparked widespread use of digital technology in dentistry in the early nineties. Digitalization and technology have limitless potential in prosthodontics, whether in clinic or laboratory operations [4]. A wide range of digital solutions are known, and several are being investigated; some of them are as follows: (i) Computer-Aided Design-Computer Assisted Manufacturer (CAD-CAM) technology, (ii) Rapid prototyping, (iii) Stereolithography, (iv) CEREC system etc.

1.1 Background

New technology has advanced swiftly in recent decades, transforming the planet and our daily lives. The digital revolution has considerably improved our way of life, from smartphones to smart automobiles. These innovations have a significant influence on the healthcare profession as a whole, and dentistry is no exception. We have entered a new era of digital dentistry. New digital gadgets and processing software, as well as attractive materials and strong production techniques, are profoundly altering dentistry. These changes have greatly improved the entire experience of both dental professionals and patients, enhancing services and care in ways we could never have envisioned. Today, an increasing number of dental clinics and labs see the value of becoming digital. Those practises that embrace digitization will eventually earn significant advantages in terms of result quality, cost savings, and time savings.

1.2 CAD-CAM Technology

CAD-CAM technology allows computerized milling to be used to produce dental restorations like implants, dentures, inlays, and onlays. CAD-CAM technologies are among the few that have attained widespread adoption. It provides superior restorative manufacturing relative to dental composites [1]. It is quicker, less expensive, more predictive, stable, and much more precise.

CAD/CAM is commonly utilised to create maxillofacial prosthesis, extraoral radiation devices, personalised breathing masks, and face protection systems. CAD software is used to image threedimensional surfaces. This 3-D surface picture assists in the manufacturing of a resin model using the Lithographic process, followed by the creation of a wax print. This completed wax pattern is subjected to computer-assisted three-dimensional imaging once again. Data is input onto a computer, and a computer-aided milling machine is used to mill the prosthesis. As a result, CAD/CAM technology is used to create a silicone maxillofacial prosthetic.

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Advantages	Disadvantages
·Faster and easier than traditional impressions ·Because measurements and manufacturing are so accurate, the quality of CAD/CAM restorations is exceedingly good. ·All scans may be saved to the computer.	·The initial investment in equipment and software is substantial. ·The practitioner must invest time and money in training. ·Dentists who do not perform a big enough volume of restorations will struggle to make their investment pay off.

1.3 Rapid Prototyping

Rapid prototyping is the automated creation of physical components from graphical digital data. Rapid prototyping refers to a group of new methods that produce specialized components in a matter of hours straight from CAD designs, with zero human intervention required. It's a sort of computer-aided manufacturing [14]. It is utilized to make obturators, surgical stents, burn stents, nasal and auricular prostheses with a 0.1 to 0.4 mm accuracy rate.

Advantages	Disadvantages
·Design and development time has been reduced. ·Overall product development costs have been reduced. ·Risk elimination or reduction ·Functionality testing is possible for a fraction of the expense. ·Capability to assess human factors and ergonomics	·Some fast-prototyping procedures are still prohibitively expensive and inefficient. ·Material qualities such as surface quality and strength have been reduced. ·Rapid prototyping necessitated the use of expert labour. ·Material selection is limited. ·Overlooking certain critical features due to their inability to be prototyped has an impact on prototype testing.

1.4 Stereolithography

The stereolithography process is utilized to make contact-free facial reproductions, duplicate copies of anatomical sections, and can account for patient development and material flaws. Surgical and prosthodontic implant preparation and insertion are done using stereolithography surgical templates [15]. It is a low invasive medical approach that may be conducted without elevating the flap and results in rapid functional loading of the prosthesis.

Advantages	Disadvantages
·Component can be constructed in a very short amount of time ·It is quite inexpensive to make in large quantities. ·Almost any component may now be created from the ground up using stereolithography.	·Handling the resin becomes an important component in stereolithography since it must be treated correctly. ·Newer processes may be superior.

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1.5 CEREC System

The CEREC technology stands for ChairSide Economical Restoration for Esthetic Ceramics. It is utilized with ceramics and composite blocks. This technology offers both automated and manual modes. The biogeneric copy function is well-known in the CEREC platform [11]. This biogeneric copy entails the precise duplication of the dental tissues relative to the original pre-existing tooth, which eliminates laboratory mistakes and ensures that the crown fits correctly.

Advantages	Disadvantages
·Restore your teeth's function as soon as possible. ·It saves you money. ·Keeps teeth from decaying	·Traditional crowns are more resistant to breakage and wear and tear, making them more long-lasting. ·If tooth's fracture extends beyond the gum line, the CEREC camera cannot effectively collect the picture.

1.6 Digital Impressioning

In terms of efficiency, digital impressions outperform traditional impressions by a wide margin. Re-scans take less time since only missing and unsatisfactory sections are rescanned, whereas traditional impressions require the full arch to be retaken. In addition, the absence of tray fit, taste of substance, and setting time of the imprint material increases patient comfort. When a digital imprint is taken, the restoration fit is more exact. There are several oral scanner systems on the market today, including the ED4, I Tero, Lava chair side oral scanners and others. These technologies benefit the dentist by allowing design and milling to take place in the office, whereas the following systems capture impressions that may be transported to a laboratory for fabrication.

It is usual for all systems to be able to generate models distally, resulting in prosthesis.

Advantages	Disadvantages
·It improves the quality, consistency, and accuracy of the imprint. ·Visualization of preparation from all perspectives for the creation of the prosthesis. ·If required, instant display and feedback for corrective actions.	·Initial Investment is Expensive ·Learning curve is steep. ·Scanning moveable soft tissue is difficult. ·For the mandible, this is frequently not achievable.

II. CHAPTER 2 - DISCUSSION

When contrasted to traditional treatments, digitalized approaches have significantly enhanced a range of dental reconstructive features, encompassing diagnostics, recovery, and treatment of patients with difficult clinical situations. The subsequent decade of effort by first users fueled the development of digital technology as the approaches and benefits grew.

2.1 The Benefits of Digital Technology

The numerous advantages of digital prosthodontics may be divided into four groups.

1. The first is better communication. E-patient records, which provide portals for easy interchange across doctors, patients, dental lab workers, and third-party stakeholders, improve communication efficiency.
2. The second benefit is higher quality. This multilayered quality enhancement improves productivity and effectiveness, data storage, data validity, and treatments. According to a recent comprehensive study and meta-analysis, digital impression methods gave superior marginal and internal fit of permanent restorations than traditional procedures.

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3. Personalized patient database storage is the third benefit. Owing to the great quality of the scanned picture, virtual diagnostic castings could be preserved. The low price of storage has enabled the archiving of vast quantities of big datasets, allowing for the recovery of full patient records for year-to-year assessments.
4. The fourth and most crucial advantage of digital technology in Prosthodontics is the improved patient experience. The advancement of diagnostic data informs better treatment approaches.

Table 2.1 Benefits of Digital Technology

	Practical	**Education**	**User**	**Clinical Environment**	**Social Environment**
Benefits	·Savings on expenses ·Saving on space · high - quality ·Archival storage	·Dental schools are given practical benefits. ·Education is supported by industry. ·Profitable educational possibilities	·Market advantage ·Workplace Regulations ·Support in the laboratory	·Technical assistance ·In-place digital environment ·A workplace with many doctors ·Frequently required and used	·Local dental groups' assistance ·Assistance from a local lab

The development of patient-specific instruments as surgical manuals has facilitated innovative approaches in oral, maxillofacial surgery and dental prosthesis treatment. Precision, accuracy, and communications work together here to improve the treatment outcomes and the patient experience for the doctor, technicians, and both [13]. Furthermore, computerized processes offer the user greater influence over the designing and fabrication of permanent replacements.

Other diagnostics methods involve the accurate digitization of images and testing castings. The benefits of digital images are the minimal storing costs, the archival aspect of the material, and the general correctness of images. Approval must be obtained as part of the digital health database, and information storing and usage must comply with HIPAA requirements [7]. Apart from recordkeeping, digital imagery improves communications across the doctor, patient, employees, dental lab technicians, as well as relevant users. Although the expense of digital imaging is no longer an obstacle to its usage, its frequent employment in diagnosis stages still encounters difficulties in practice.

2.2 Barriers to The Adoption of Digital Technology

According to specialists, the key motives for embracing or dismissing a novel innovation are the comparative benefits it provides over the traditional ways it replaces, which may be separated into time, monetary, and therapeutic benefits [14]. Because digitalization brought a new set of skills i.e. computers, its acceptance has been somewhat delayed. This created concerns about comparative quality and shifted financial decision-making from commodity-based to capitalequipment-based ones. Early prices, possible financial hazards, time, and unsolved doubts about the digital solution's authenticity seem to be frequent hurdles to technology implementation across many professionals.

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Table 2.2 Barriers and incentives to adoption of digital technology

	Practical	**Education**	**User**	**Clinical Environment**	**Social Environment**
Barriers	·Expense ·Curve of Learning ·The degree of difficulty ·Investment in associated capital (space, IT support)	·Gaining access to new information ·In dental schools, practical obstacles are created.	·Inadequate fundamental computing skills ·Access to fresh data is limited.	·Peer assistance is missing. ·Lack of IT expertise or assistance ·Inadequate dental laboratory assistance	·In the community, there is a lack of encouraging teaching. ·Local laboratory support is lacking. ·There is little industrial support.

Most clinicians' first hurdle to climb is acceptability, which involves a review of the tech's possibilities for improving treatment quality. Problems include restorative adaptations and fit, material sturdiness, aesthetic results, and the clinical life of the replacement. This hurdle is dissolving due to the substantial quantity of documented data of the anticipated results and lifespan of chairside CAD/CAM reconstructions, and the enormous quantity of professional case studies illustrating how to attain favorable clinical results [16]. As curiosity in digital innovation grows, dentists will gradually get a greater understanding of chairside digital dentistry's use, limits, and successes.

One of the most prevalent hurdles to incorporation is a considerable financial expenditure on the technology. This indicates a substantial shift in how dental clinics think about treatment expenses. Cost of materials, fabrication prices, and the logistics of transferring impressions, models, and replacements are all deemed reasonable charges of delivering restorative care. Costs are frequently set by parties outside of the practice instead of by the institution itself. The return on investment for chairside CAD/CAM tech is predicated on reducing these expenditures and retaking the time wasted with the non-productive second visit linked with postponed restoration service after the preparatory session. This indicates that the monetary constraints are focused on assuring a return on investment instead of initial expenditures. As professionals learn how to minimize expenses and make visit hours more effective, the monetary hurdles become less daunting.

2.3 The Impact of Digital Technology in Dental Education

Educationalists are experimenting with developing digital tools in the prosthodontic field exclusively. According to a recent study of US dentistry school deans, digital technology adoption was highest in preclinical instructional programs and least in the preclinical laboratory [13]. Dental education will benefit from digital technologies. This is very useful for teaching restorative methods.

- Technology allows for greater self-assessment and even a virtual learning space.
- Dental trainees receive immediate, accurate, and visible information, allowing for improved self-assessment.

The employment of digital technologies entered into dentistry school courses through the laboratory business that supported clinical activity. Most single-unit crowns are now made utilizing a computerized approach. Several dental institutions have successfully implemented a chairside milling technique for digital crown fabrication. In fact, academic staff views tend to favor even a CAD/CAM chairside crown, suggesting a preference for digitally manufactured restorations. When students were polled, 86% said they liked constructing a complete contour crown with CAD, whereas 14% liked the wax-added procedure. In terms of digital denture technologies, a recent study found that around 50% of post-graduate prosthodontic schools incorporated components of this innovation in their coursework, but only 14% of undergraduate programmes incorporated components of digital technologies in their coursework. Most instructors, however, want to integrate digital denture manufacture in their courses by 2020. Dental educationalists must

immediately integrate digital technology since its educational benefits are significant.

2.4 Computer guided surgery

Originally developed for neurosurgery, computer-guided surgery offers various benefits to dentists, including the ability to accomplish predictable and safe implant placements. Despite the benefits, the number of implant dentists who employ this method is still small. According to data from the dental implant industry in the United States, less than 15,000 computer-generated surgical guides were used in 2012. More than two million implants are anticipated to have been implanted in the same year! The number of computer-generated surgical guides is expected to rise to 31,000 by 2019, although this remains surprisingly modest in comparison to the growing popularity of implant surgery.

The pictures from the patient's cone beam CT scan are used to accurately arrange implant therapy in computer-guided surgery. Guided surgical software allows you to see and alter photographs of the patient's jawbone and surrounding tissue, allowing you to determine the most correct treatment strategy. Cone beam CT scans effectively depict the accessible bone, soft tissue thickness, essential structures, root architecture, and the closeness of neighbouring teeth.

2.5 Robots in Dentistry

Robots are not as widely employed in dentistry as they are in medical. Dentistry utilises a few manual robotic systems that are controlled manually via the computer's control interface. Manual drills can be safer and more precise than standard drills. Although progress toward autonomous robots in implant dentistry is being made, the few viable robotic devices are not currently available to dentists. Before robots become prevalent in dentistry practise, the high purchase cost and inherent complexity of robotic hardware and processes must be addressed.

2.6 Future of Digital dentistry

Prosthodontics is a speciality that will proceed to influence the entire field in embracing innovative treatments and enhancing clinical results. Present digital prosthodontics technology is built on concepts and industrial practices that have been used in dentistry for years. Ceramic improvements have broadened the application of milling technique, which is being improved via research and clinical initiatives. Dental laboratories have shown the incredible advantages of digital workflows, and physicians are quickly embracing them. We are currently experiencing benefits in productivity, efficiency, and accuracy as a result of digital technology [1]. Imagery and manufacturing will advance in the coming years. Surface scanning equipment advancements and imaging application advancements will boost our design skills. Fabrication technology advancements, particularly additive techniques for metals and polymers, will allow for the quick creation of prostheses and parts to handle the intricacy of developing treatments such as lingual orthodontics, whole mouth rehabilitation with partial coverage ceramics, and oral and maxillofacial grafting techniques. The digital dental operatory and labs will grow more integrated and more suited to the difficulties of enhanced clinical treatments.

III. CHAPTER 3 - RELATED STUDIES

Mühlemann et al. performed a poll to establish the quantity of digital technology used for patient observation and treatments in dental practices. Based on the survey, the higher the degree of digitization of the dental clinic, the younger the doctor, the latest the clinic's establishment, the greater the patient targeting zone, and the more patient rooms.

Schlenz et al. used a questionnaire to examine students' views on the implementation of digital dentistry in similar research. On grounds of management, instructional value, and inspiration, the students rated the utilization of digital factors in education as desirable, although they favored dental teachers to evaluate tooth preparations [8]. Over 90% of students stated they could envision themselves using an intraoral scanner to handle patients in the dental clinic in the future.

Shah undertook a study to look into breakthroughs and advances, and also the impact on both patients' and doctors' treating times and performance. It was discovered that almost every responder employed digital technologies on a daily routine [10]. Patient contentment with treatment results has improved in most of the cases. All respondents said they would utilize digital dentistry in the future.

According to Jain et al., the progress of digital technology has benefited in the fabrication of 3D models predicated on digital samples utilizing a computer numerical control (CNC) platform. Through the help of a process known as computer-aided design (CAD), Computer systems can now be utilized to create perfectly accurate designs that can be examined from several perspectives, a process [2]. A computer-aided manufacturing (CAM) technique has been devised to manifest virtual objects produced with CAD. A

tool attached to a computer is used to turn a digital document into a tangible object in CAM. CAD/CAM techniques employ a non-invasive 3D imaging device. This article provides an understanding of the many types and uses of CAD/CAM technology.

Nassani et al. undertook this study in Riyadh, Saudi Arabia, to investigate dentists' opinions and habits related to chair-side CAD/CAM technologies. A random sample of dentists was sent an online questionnaire. Queries were asked on chair-side CAD/CAM technology use, views, and education. The vast proportion of respondents (81%) feels that the general performance of chairside CAD/CAM replacements is nearly as great as, if not better than, that of lab-fabricated replacements [6]. The majority of responding dentists saw chair-side CAD/CAM technologies as critical in areas of lowering time, boosting the number of regular patients, and improving income.

A large percentage of dentists expressed an interest in studying chair-side CAD/CAM techniques (75.4 per cent). The findings of this experimental research reveal that the questioned dentists are quite satisfied with the use and benefits of chair-side CAD/CAM technologies in dental clinical practice and that they have a positive perspective toward it.

Balakrishnan et al. studied undergraduate dental students' willingness to use digital and computerized technologies in the field of dentistry. In Chennai, India, 356 dental undergraduates took part in a cross-sectional study. A questionnaire was developed and forwarded to dental undergraduates to assess their knowledge of digital prosthodontics. The collected dataset was statistically evaluated, and results were obtained. 356 students responded to the questionnaire [3]. There were 46% men and 56% women among those. The employment of the Internet and other technologies was popular amongst dental undergraduates, according to 93% of students, and 45 per cent of students were confident that teledentistry allows for interactive classes and real-time appointments using videoconferencing. Based on the findings of this study, dental students have an asymmetric comprehension of digital dentistry. As a result, education programmes to foster positive views are required.

Another research by Pandey et al. sought to examine professionals' expertise, attitudes and practices surrounding the implementation of digital dentistry in endodontics. Questionnaire-based poll with 15 questions divided into understanding, mindset, and practitioner areas. After evaluating the survey responses, it was determined that the majority of dentists were enthusiastic to use digital dental methods [11]. When the quantitative analysis was done on the subject related to this tendency for improved treatment results, very considerable values of p Value as '0.001' were found. Additional crucial findings involve Titanium Oxide powder being employed with CEREC Systems with p Value as '0.038', which was statistically noteworthy. Within the scope of the research, it shows that participants' knowledge of digital dentistry-based therapies is limited in comparison to their mindset and practicing. The majority of respondents, as per the research, desired to increase their CAD-CAM understanding and skills.

IV. CHAPTER 4 - CONCLUSION

Dentistry benefits greatly from digital technologies. While these benefits are frequently striking and easily differentiate digital from traditional procedures, implementation has been progressive. The benefits of enhanced communications, more control, superior quality and information storage, and enhanced patient experiences may be seen in all digital dentistry activities, from digital health information to selective laser sintering of complicated prosthetic systems. Given the broad and various particular benefits of digital dentistry, considerable hurdles to implementation exist. Numerous elements impacting technology implementation, such as awareness and education, are sometimes neglected as key facilitators of implementation. Underrecognized issues that restrict acceptance include a lack of knowledge and expertise required to effectively incorporate and use the technology.

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