DENTAL SCULPTURE – CAD/CAM (ONE DAY CROWN)

Naresh[1], Padam Singh[2], Gursandeep Kaur Sandhu[3], Sunil Malhan[4], Shubham Sharma[5]

[1]Professor, Department of Oral surgery, Desh Bhagat dental College and Hospital, Mandi Gobindgarh

[2]Professor, Desh Bhagat dental College and Hospital, Mandi Gobindgarh

[3]Professor, [4]Professor & Head, [5]PG Student Department of Conservative Dentistry and Endodontics, Desh Bhagat dental College and Hospital, Mandi Gobindgarh

ABSTRACT

Digital dentistry, including CAD/CAM dentistry, is perhaps the most disruptive innovation in dentistry to date. The rapid development of digital dentistry technologies over the past several decades has enabled clinicians to improve patient care by significantly reducing the time necessary for the restorative phase of treatment. Advancements in intra-oral scanning and computer-aided design and manufacturing (CAD/CAM), in conjunction with new dental CAD/CAM ceramic materials, have simplified patient care and made same-day dentistry a reality. This review aims to present the most recent advancements described in current literature as well as to document the successful implementation of digital dentistry into a predoctoral program. The overall process of CAD/CAM same-day dentistry and the accompanying advancements in software and materials were presented and discussed. Implementation of technology and personnel requirements were reviewed. CAD/CAM dentistry has been influential in shaping and improving dental practice and education, and this influence will only continue with time.

Keywords: CAD/CAM; dental ceramics; dental technology; digital dentistry; dental education; dental innovation; disruptive technology

INTRODUCTION

Mormann was the person who introduced first commercially designed CAD CAM system in the year 1985 and given the name of CEREC to that system.[1] He fabricated an inlay from a ceramic block after taking digital impression from intra oral camera. That was bit easy as compared to take impression of a prepared abutment tooth. Now this system is being used all over the world successfully for the fabrication of crowns, inlays, onlays etc. Dr Andersson developed Procera system in the mid-1980s and worked on titanium as a substitute of nickel chromium alloys.[2]Nowadays CAD/CAM systems may be categorized as either chairside or laboratory systems. The first commercially available CAD/CAM system has been CEREC, developed by Mormann and Brandestini. This chairside system allows the clinicians in private offices to in dependently design and also machine dental ceramic restorations in matter of hours, enabling re construction during single visit[3]CEREC 2 was introduced in 1994 by Siemens. This system was based on two dimensional principles and capable of producing inlay, onlay, veneers, partial & full crowns and copings. Currently 3rd generation of CEREC is in use, which is capable of producing inlay, onlay, veneers, partial & full crowns, copings as well as virtual automatic occlusal adjustment. This system was introduced by Sirona in 2005. This system is basically the advanced form of CEREC 3 which was earlier introduced in 2000 by Sirona but that system worked on two dimensional principles and was not able to provide virtual automatic occlusal adjustments.[4]

Table 1. Indications and Contraindications for Same-day Dentistry[5]

Indications	Contraindications
Ideal crown preparation	Subgingival margin
Angulation of the preparation is optimal for intraoral scanning	Angulated abutment not allowing intraoral scanning
Optimal mouth opening	Limited mouth opening
Esthetics (optimal for monolithic or minor layering ceramics)	Esthetics (may require complex layered ceramics)
Single unit restorations	Fixed partial dentures or multiple single units

CAD/ CAM Procedure: 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 materia[16].

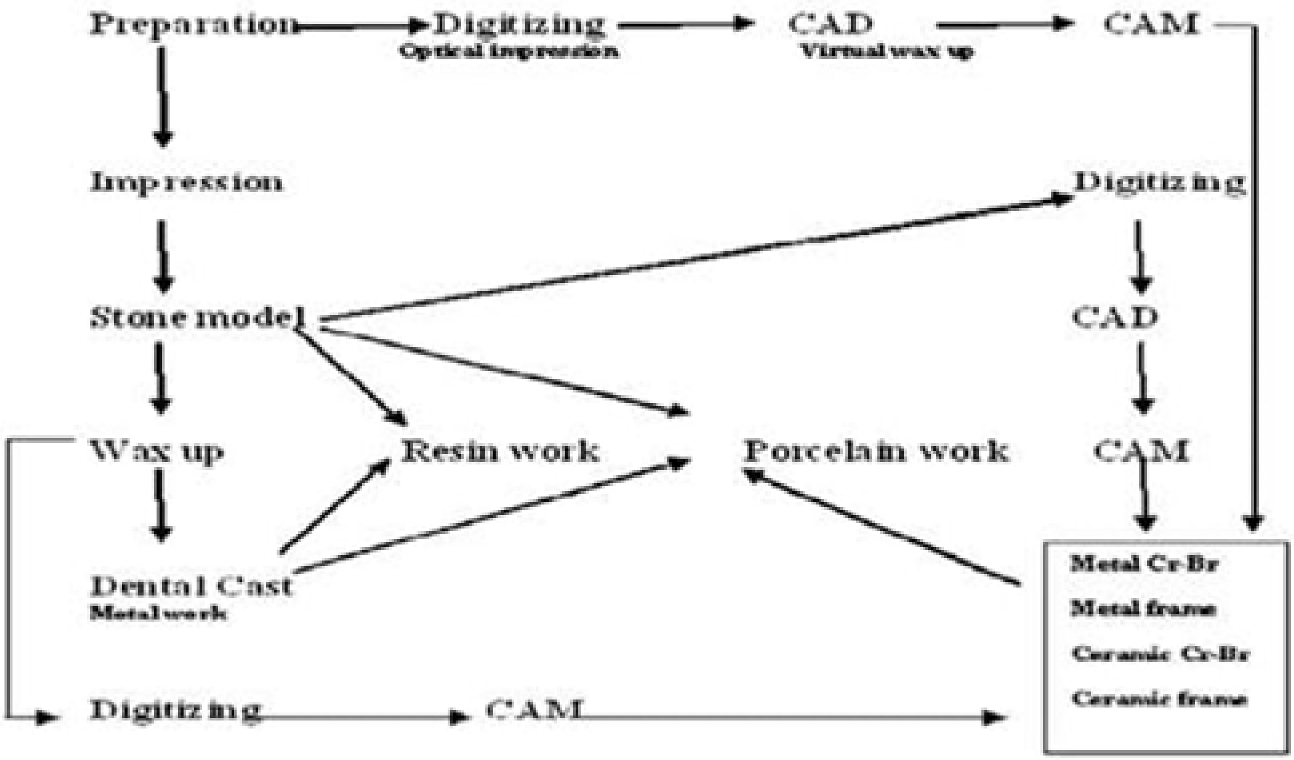

Fig. 1: Overview of CAD/CAM Process

1. Intra oral scanning There are several intra oral scanners available in market namely CEREC® - by Sirona Dental System GMBH (DE), Lava™ C.O.S. - by 3M ESPE (US), iTero - by CADENT LTD (IL) and E4D - by D4D TECHNOLOGIES, LLC (US) etc. What these systems do, they take 3-D virtual picture of the prepared tooth/teeth and the adjacent structures, directly into the patient's mouth Later on these images transfer to the CAD for designing of the prosthesis[7]

The monolithic nature of CAD/CAM materials enables a minimal thickness, thus giving clinicians the opportunity to prepare natural tooth abutments in a more conservative way than ever. This includes the minimal preparation of the abutment finishing line margin. A recent study by Rizonaki13 evaluated three types of finishing line on a typodont system--rounded shoulder, chamfer, and feather-edge--in 30 lithium disilicate crowns, 10 for each type of finishing line. Microcomputer tomography was used to evaluate the internal fit, marginal gaps, and 3D cement volume. While all three finishing lines provided clinically acceptable values, the rounded shoulder preparation appeared to provide the smallest gap width and discrepancy in the 2D measurements. The internal gap width was smaller in the chamfer and feather-edge margins compared to that of the round shoulder. When measured in 3D, the cement gap was also smaller in the chamfer and feather-edge margins than the round shoulder margin. While all three finishing lines are clinically acceptable, the chamfer finish line design may provide a compromise between conservative tooth preparation and filling of the restoration compared to the shoulder design, which requires more tooth preparation, and the feather-edge design, where it may be difficult to define the margin. Depending on the y ria concentration of zirconia, the minimum thickness of 3 MOL% y ria monolithic zirconia material can be as low as 0.7 mm to 1 mm thickness for posterior restorations under heavy occlusal load.[5]

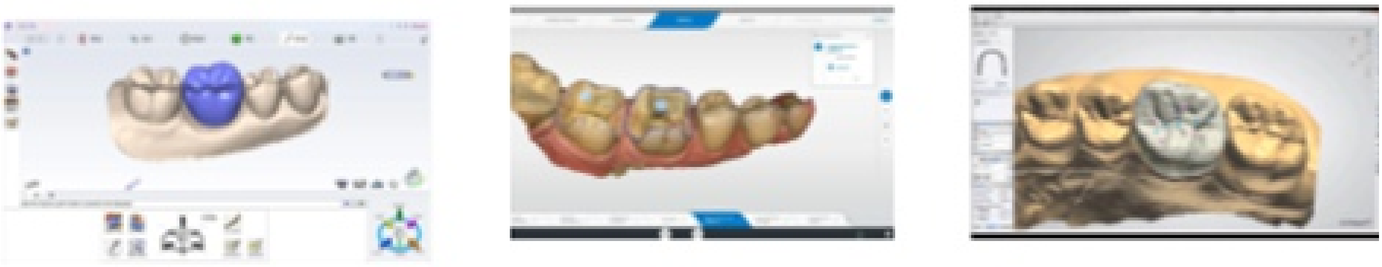

Fig.2: intra oral scans

1. Milling Systems: Milling Materials and Milling Machinery
Most dental restorative, definitive, provisional, or intermediate materials can be milled using most current milling systems (Figure 3). Two of the most commonly used materials for same-day dentistry and in-house fabrication of fixed prostheses are lithium disilicate and zirconia. While lithium disilicate material has remained largely unchanged since its introduction in 2006, zirconia material has further developed and modified to optimize the material's physical and esthetic properties. The milling systems of these two materials are similar in both design and functionality; however, lithium disilicate milling is often accompanied by a water-based coolant to reduce frictional heat generated during the milling process. Unsintered lithium disilicate shrinks by only ~0.2-0.3% of its volume after sintering[8] as the unsintered material is relatively dense and therefore allows limited water penetration. In contrast, unsintered zirconia material has higher porosity, and it shrinks by 18-24% of its volume after sintering.9The porosity of the unsintered zirconia makes it prone to water contamination, which can, in theory, adversely affect the physical properties during the sintering process.

Fig.3 Milling Systems

Sintering : The sintering process and time can be a significant factor in the workflow, especially for same-day restorations. Lithium disilicate often requires only a short period of time for sintering and potentially simultaneous characterization and glazing, takingabout 10-15 minutes. Including time to cool down, the process takes about 30 to 45 minutes. With this in mind, a lithium disilicate restoration can easily be completed in one half-day, including tooth preparation, intraoral scanning, restorative designing and milling, optional try-in the unsintered stage, final trying of the definitive restoration, and cementation. Zirconia, on the other hand, requires a longer sintering time, especially the more translucent zirconia with a higher y ria content. Chairside "fast-sintering" CAD/CAM zirconia blocks (e.g., 3M Chairside zirconia, 3M and Katana STML) have been introduced to reduce sintering time from 8 hours to 20 minutes by using special speed-sintering furnaces (e.g., CEREC Speedfire, Dentsply).10Post-sintering, zirconia also requires polishing and glazing. Understanding the materials used in practice will help you choose an appropriate milling machine and sintering furnace (Figure 4).

Fig.4Examples of current sintering and glazing furnace systems: each system is designed for sintering and glazing of specific materials.

1. Luting Cements and Cementation Procedures

Monolithic CAD/CAM ceramic restorations can be luted with conventional cements (such as resin modified glass ionomer) or with composite-based resin cements, depending on the preparation design of the abutment.[11]However, bonding of lithium disilicate and zirconia has recently been shown to provide additional retention and possibly a longer-lasting survival of the restoration. For lithium disilicate, a 5% hydrofluoric acid and silane are often used. A more recent innovation from IvoclarVivadent (Monobond Etch and Prime) combines both the etchant and the primer in one application . The conditioner appeared to roughen the surface of lithium disilicate, seen in electron microscopy to have a similar effect to the hydrofluoric acid, and produced a cohesive failure during debonding testing.[1213] However, while the bond strength may be adequate for restorations that do not require additional retention,still lower than that of hydrofluoric acid and silane. As a result, restorations that require maximum retention form should continue to use hydrofluoric acid and silane applications

BENEFITS AND DRAWBACKS OF THE CHAIRSIDE SYSTEM14

Operative Step	Benefits	Drawbacks
Tooth Preparation	Higher simplicity, due to margin positioning: supra or juxta gingival Micro-invasive preparations: lower removal of dental tissue, i.e. less time and decreased risk of pulpal necrosisNo needs for traditional retention design (height, width, and taper) due to adhesive luting Preparation Time Saving Fast and efficient healing of the soft tissue due to superficial and atraumatic positioning of the margins No need for provisional restorations	The preparation must be appropriate to the capacity of the milling unit Sub-gingival margins: working field isolation, adhesion procedures, impression taking, final positioning of the restoration
Milling Unit Capacity	Shortened Production time Several materials available	Influence of the tooth preparation design
Impression	Faster than traditional procedure Costs: no need for impression material Better acceptance of the procedure by the patient due to higher simplicity The elimination of the gingival retraction operations due to superficial positioning of the finishing line The simplification of the soft tissue healing due to atraumatic and atraumatic positioning of the margins Reduced inflammation and patient involvement thanks to the absence of cords	Sub-gingival margins: coronal relocation of the margin, surgical exposure of the margin, clinical crown lengthening
Design	Immediate visualization of the tooth preparation by the clinician Possibility for a prompt correction (axis, taper, finish lines length) Margin positioning in length Possibility for the patient, the extension and the pressure of the pontic Possibility for the clinician the extension and the pressure of supragingival contact area	Absence of gnathologic data and prosthetic functionalization
Materials	Wide selection of materials High standardization due to reproducible and high standard manufacturing process Shortened milling process High esthetic outcome Shortened timing	Type of restoration
Adhesive Luting	Choice of the cement shade according to tooth and restorative material colours	Procedure Time Post-operative sensitivity Perfect isolation and working field Sub-gingival margins

CONCLUSION

CEREC CAD/CAM single-day crowns offer a highly efficient and convenient solution for dental restorations, combining digital precision with same-day treatment. This technology eliminates the need for multiple appointments and temporary crowns, enhancing patient comfort and satisfaction. While initial costs and training requirements may be higher, the long-term benefits for both patients and practitioners—such as improved accuracy, time savings, and durable restorations—make it a valuable advancement in modern dentistry.

REFERENCES

1. Mormann WH, Brandestini M, Lutz F, BarbakowF.Chairside Computer Aided Direct Ceramic Inlays. Quintessence Int 1989;20:329-339
2. T Miyazaki, Y Hotta, J Kunii, S Kuriyama, Y Tamaki.A review of dental CAD CAM: Current status and future perspectives from 20 years of experience.Dent Mat Jour 2009;28:44-56.
3. Mörmann WH, Krejci I. Computer-designed inlays after 5 years in situ: clinical performance and scanning electron microscopic evaluation. Quintessence Int. 1992;23:109-15.
4. WH, Mormann. The evolution of the CEREC system.J Am Dent Assoc 2006;137:7S-13S.
5. Bencharit S, Clark WA, Stoner LO, Chiang G, Sulaiman TA. Recent Advancements in CAD/CAM Same-day Dentistry in Practice and Education. Materials 2021, 14, x. h ps://doi.org/10.3390/xxxxx
6. Freedman M, Quinn F, 2007, 'Sullivan M. Single unit CAD/DAM restorations: a literature review.' J Irish Dent Assoc, vol. 53, pp. 38-45.
7. A Kilpeta, M Capni, L Governu, L Blois.A comparative analysis of intra oral 3D digital scanner for restorative dentistry. The Int Jour Of Med Tech 2008;5. 12. Gary Davidowitz, Philip G. Kotick. The Use Of CAD /CAM in dentistry. Dent Clin N Am 2011;55:559 570.
8. Wang, H., Liao, Y., Chao, Y. & Liang, X. Shrinkage and strength characterization of an alumina-glass interpenetrating phase composite for dental use. Dental Materials vol. 23 1108-1113 (2007).
9. Oh, G.-J., Yun, K.-D., Lee, K.-M., Lim, H.-P. & Park, S.-W. Sintering behavior and mechanical properties of zirconia compacts fabricated by uniaxial press forming. J. Adv. Prosthodont. 2, 81-87 (2010).
10. Sulaiman, T. A. Materials in digital dentistry-A review. J. Esthet. Restor. Dent. 32, 171-181 (2020).
11. . Zarone, F., Di Mauro, M. I., Ausiello, P., Ruggiero, G. & Sorrentino, R. Current status on lithium disilicate and zirconia: a narrative review. BMC Oral Health 19, 134 (2019).
12. El-Damanhoury, H. M. &Gaintantzopoulou, M. D. Self-etching ceramic primer versus hydrofluoric acid etching: Etching efficacy and bonding performance. J. Prosthodont. Res. 62, 75-83 (2018).
13. Scherer, M. M. et al. Fatigue failure load of an adhesively-cemented lithium disilicate glass-ceramic: Conventional ceramic etching vs etch & prime one-step primer. Dent. Mater. 34, 1134-1143 (2018).
14. Sannino G, Germano F, Arcuri L, Bigelli E, Arcuri C, Barlattani A. CEREC CAD/CAM Chairside System. Oral Implantol (Rome). 2015 Apr 13;7(3):57-70. PMID: 25992260; PMCID: PMC4402686.