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Machined Ceramics: The Future of Restorative Dentistry

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Abstract: *The aesthetic demands of the patients has resulted in an increased use of dental ceramics and has generated enhanced research in this field, leading to tremendous changes in the composition and processing techniques of dental ceramics in the past three decades. Improvements in strength, clinical performance, and longevity have made all ceramic restorations more popular and predictable. Also, technology has been able to provide solutions to many of the routine hassles in dental practice. This review aims to provide an update on some of the recent advances in the production of all ceramic restorations. PubMed (with subject headings), Wikipedia and Google Scholar searched using the following terms "Dental Ceramics", and "Computer-Aided Design/Computer Aided Manufacturing (CAD/CAM)". This was supplemented by hand-searching in peer-reviewed journals and cross-referenced with the articles accessed. In this brief review, we will discuss advances in fabrication techniques with potential of allowing the delivery of single visit restorations*

Keywords: *Ceramic Crowns, Computer-Aided Design/Computer Aided Manufacturing (CAD/CAM)*

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I. Introduction

The level of aesthetic demand in clinical practice has increased over the past decade, and this has made it essential for the dentist to explore the field of ceramics in order to satisfy the patient's requirements. As we go back in the past, a French dentist De Chemant patented the first porcelain tooth material in 1789[1.] The development of aluminous core and veneer porcelains was first described in 1965 by McLean and Hughes [2,11]. In 1987, Mormann and Brandestini introduced a prototype machine that would capture a 3-D image of a prepared tooth then directed the computer-aided milling of inlays and onlays from solid blocks of aesthetic, filled-glass ceramics[1] The development of computer-aided design and computer-aided machining method for the fabrication of inlays, onlays, crowns, and bridges has led us to the development of next generation of machinable ceramic restorations that can be delivered to the patient in a single appointment since these are made chair-side. The objective of this article is to review the advantages and disadvantages of this technology and a quick overview of the available systems that provide such treatment options

1.2**Features Of Cad/Cam Technology**

1.2 Merits of CAD/CAM technology

1. Designs, fabricates and places all ceramic restoration in a single patient visit
2. Restorations have demonstrated excellent fit, strength and longevity
3. Using CAD/CAM technology, a number of steps are simplified
4. The hassle of conventional impression, soft-tissue retraction and hemostasis for accurate record is eliminated

1.3Demerits of CAD /CAM technology

1. Expensive
2. Care must be taken to ensure that the whole preparation is scanned, to avoid introducing errors
3. Skilled technicians required to handle the systems.

1.4 Systems For Cad/ Cam Restorations

1) Cerec

Stands for Chair side Economical Restoration of Esthetic Ceramics. It Was developed by W.Mormann & M. Brandestini at the University of Zurich in 1980[2]. This system allows to construct, produces and inserts individual ceramic restorations directly at the first appointment [3]. The CEREC 1 system was introduced in dentistry in the year 1987, while CEREC 2 was introduced in the year 1994 with indications such as inlays, onlays and veneers. The windows based CEREC 3 system was introduced in the year 2000[2]. The first three systems were based on 2D technology, while 3D based software was introduced in 2003. In the year 2009, CEREC Bluecam was introduced with short-wave blue light, thus significantly increasing the precision as compared to the previous 3D cameras. In The latest development in the CEREC technology is the introduction of a CEREC Omnicam launched in 2012 that allows powder free digital impression. Clinical studies have revealed that the success rate of CEREC restorations is 95.5 percent following a period of 9 years [4]

2) Celay

This system was developed in the year 1988 at the University of Zurich by Dr. Stephen Eidenbenz. It works on the principles of copy milling. Copy milling is based on the pantographic principle that uses exact mechanical-tactile model surveying and analogous milling. Pattern is fabricated in wax or composite and is mounted on the scanning side while ceramic blocks are mounted on the milling side [5]. Suitable scanners trace the pattern while corresponding milling tool mills the ceramic block.

3) Procera

It was developed by Dr. Matts Anderson and was world's first practical application of outsourced fabrication of alumina cores for all ceramic crowns[6]. The system consists of a CAD scanner that digitally scans and measures the stone model. The digitized data was then sent to the manufacturing centres via internet, in the form of 3D image that can be altered to obtain perfect results. These frameworks were sent back to the laboratory for completion by layering compatible porcelain on the framework

4) Cercon

Produces metal free single crown to long span bridges. Developed in the year 2002, exploits the properties of strength toughness and biocompatibility of zirconia and demonstrates in vitro performance similar to porcelain fused to metal. The cast model is sprayed with the CERCON Eye Scan spray, which balances the optical properties of the plaster. CERCON eye scans the prep, CERCONArt 3.1.5. software is used to modify the prep and the CERCON brain manufactures the restoration and the Cercon Heat producing unit sinters the restoration for 6 hours at 1,350 degrees C.[7]

5) Lava

This system was developed in the year 2002. The Lava All Ceramic system comprises of CAD/CAM procedure for fabrication of Yttria-tetragonal zirconia polycrystal (Y-TZP) cores and frameworks for all ceramic restoration. With the LAVA system the die is scanned by optical process and through CAD softwares, the frameworks are fabricated from presintered zirconia to produce high strength restorations with excellent fit with gap as low as 21 microns [8]

6) Turbodent

The TurboDent System (TDS) milling centre began full production in the year 2005. The operator can scan the stone model with the TDS scanner and prosthesis is designed with the help of TDS Designer. The five axes TDS Cutter is capable of milling a wide range of restorations such as inlays, onlays copings, bridge frameworks and implant superstructures. However there is no literature regarding the marginal fit of the TDS, according to manufacturer the average marginal discrepancy is 15 microns.[9]

7) **Dcs President**

The DCS Precident system is comprised of a Precision laser scanner and a Precimill CAM multi tool milling centre can scan 14 dies at a time and does corresponding manufacturing of up to 30 framework units in a single fully automated operation. The DCS Dentform software automatically suggests connector sizes and pontic forms for bridges.[9]

8) **E4D Dentist**

The E4D Dentist system is a newly developed in office CAD/CAM sytem introduced in the year 2008. Digital impression of tooth prep is recorded with the help of high speed IntraOral Digitizer without the use of reflective agents and transferred to the software which identifies appropriate color shape and biting surface for the restoration. The total process may take as less as 90 minutes making same day restorations a reality for the patients [10]

1.5Critical evaluation of CAD/CAM systems

The marginal opening is the most important factor in enhancing the reliability of newly developed CAD/CAM systems. Suleiman et al compared the marginal fit of 3 different techniques (PROCERA, IPS Empress & In-Ceram). The PROCERA and In-Ceram showed the least marginal gap. Similarly conventional lost wax techniques (IPS Empress) when compared with CAD/CAM approach (CEREC 3D), showed no significant difference in the two groups. Yeo et al studied the marginal discrepancies with CELAY and conventional In-Ceram and found that marginal discrepancies were 83µm as compared to 112 µm for InCeram.[12] Milling is a crucial step to produce accurate restorations using CAD/CAM. Five axis milling devices showed highest accuracy as compared to four axis devices.[13] Also, the precision of the restorations produced via conventional impression and Intra oral scanning technique appeared to be equivalent. However the intraoral scanning technique provides lower internal gaps in some specific areas [14]

II. Conclusion

It is important for Dentist and dental technician alike to be aware of the current technologies in their fields and be able to use it to their and their patient's advantage. The positive effect of technological innovations will reduce manual workload and enable the practitioner to concentrate on more essential things. In the near future, this technology would result in restorations that are functionally durable, aesthetically excellent with accurate margins and low wear on the opposing teeth and most significantly, less technique sensitive with ease of fabrication and less time consuming.

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