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Evolution Of CAD/CAM Materials In Prosthodontics: A Review

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Abstract:
The evolution of supportive computer technology over time has resulted in the chairside design and milling of complete crowns and multiple-unit ceramic restorations to a high standard. In the past 25 years, materials have been introduced as chairside CAD/CAM systems which have evolved. The first commercially available system was the CEREC system, developed by Professor Werner H. Mörmann. From a ceramic block, inlay was built out and was set into the affected tooth on the same day. All CAD/CAM systems have three functional components: 1) Data capture or scanning to capture and record data about the oral environment. 2) CAD to design the restoration to fit the preparation and to perform according to conventional dental requirements. 3) CAM to fabricate the restoration. This article provides information about different types of chairside CAD/CAM materials, their evolution over the years, their properties and future perspective of these CAD/CAM materials.
Keywords: *CAD/CAM, Materials, Evolution, Review Article.*

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I. Introduction

Computer-aided design (CAD) and computer-aided manufacturing (CAM) technology systems use computers for collecting information, design, and to manufacture a wide range of products with great precision linked to a milling device. The evolution of supportive computer technology over time has resulted in the chairside design and milling of complete crowns and multiple-unit ceramic restorations to a high standard. In the past 25 years, materials have been introduced as chairside CAD/CAM systems which have evolved [2].

The range of restorations that can be fabricated with a chairside system depends on the size of the milling machine, material block, and the properties of the selected material [10]. CAD/CAM resin composite and hybrid ceramic materials have been introduced recently. Despite its advantages, common application of chairside CAD/CAM technology has not yet been fully embraced. The main reasons cited for that are related to high initial and maintenance cost, a steep learning curve, and the need to change procedure that practitioners have learned in dental school [10].

All CAD/CAM systems have three functional components: 1) Data capture or scanning to capture and record data about the oral environment. 2) CAD to design the restoration to fit the preparation and to perform according to conventional dental requirements. 3) CAM to fabricate the restoration.

II. History

The first commercially available system was the CEREC system, developed by Professor Werner H. Mörmann. From a ceramic block, inlay was built out and was set into the affected tooth on the same day. The areas requiring three-dimensional shape design were limited to only a small part of the whole area. It was therefore possible for the CAD/CAM system to be constructed as a compact system. A very advanced feature of the CEREC system was the inclusion of an intraoral scanner in the system. Intraoral scanner is a key feature for the analogue-to-digital change in dental treatment [1]. Although the CEREC system could be used for the production of an inlay, it was difficult to construct producing crown and bridge, which requires capacity to freely design a three-dimensional crown form.

François Düret of the University of Southern California tried to construct a system for designing a crown shape with a wire frame on a general-purpose personal computer, but the widespread use of the systems was not achieved at that time because of the high cost of the systems and lack of appropriate new materials [2].

Alumina porcelain, which appeared later, has greater strength, but still not sufficient for a bridge of molars. They also had poor light permeability and its colour is different from the colour of teeth. Initially developed zirconia ceramic material had difficulty in transmitting light, had extremely high fracture toughness compared to that of conventional dental ceramic materials.

A 3D model scanner and dental CAD/CAM system are now being used worldwide, and an all-ceramic crown bridge using a zirconia frame is popular now [11]. Replacement of conventional milling discs with a variety of diamond burs has resulted in major improvements in milling technology. It helps -1)To produce higher and more uniform quality material by using commercially formed blocks of material. 2) To standardize restoration-shaping processes; - to reduce production costs. The use of high-strength structural materials like alumina and zirconia-based ceramics for restoration cores and frameworks, which can be shaped only by CAD/CAM systems, has both increased the lifetime of restorations and expanded the demand for CAD/CAM-produced restorations

A different additive rapid prototyping technique, 3-D printing, is being used to design and then print a wax pattern of a restoration. An advanced printing unit (Cynovad) prints a resin-type material instead of the wax. It also can be used to fabricate auricular prostheses. Integration of these technologies has resulted in the introduction of several highly sophisticated CAD/CAM systems: CEREC3 and in lab DCS Precident. However, capital costs of these CAD/CAM systems are quite high and rapid large-scale production of good quality restorations is necessary to achieve financial viability [2].

III. Evolution and Different CAD/CAM Materials

In September 1985 at the University of Zurich Dental School, Mörmann placed the first chairside ceramic restoration with the CEREC 1 system by using computer-aided design/computer-aided manufacturing (CAD/ CAM) technology. The original ceramic material for CEREC 1, Vitablocs Mark, was a fine particle, feldspar-based ceramic that could be compressed into a block and can be machined into dental restorations.

Vitablocs Mark II replaced Vitablocs Mark I in 1987, which is a fine-grained, high-glass– content feldspar-based ceramic and was the only material available until 1997. Laboratory-based IPS Empress (Ivoclar Vivadent), is fixed to the tooth by means of adhesive bonding. It was the basis of a chairside material called ProCAD (Ivoclar Vivadent) and was composed of 40 percent infiltrated leucite glass. After modifications in processing and manufacturing it improved its strength and aesthetics, ProCAD which became IPS Empress CAD which was introduced in 1998. In 1997, Paradigm MZ100 blocks (3M ESPE) were introduced. They are a highly filled (85-90 percent), ultrafine silica ceramic particle embedded in a bisphenol A-glycidyl methacrylate resin matrix. It had the advantages of containing a composite that is dense, uniform and free of polymerization shrinkage and that can be shaped anatomically in a milling machine.

In 2003, 3M ESPE introduced a 30 percent-by-weight leucite block called Paradigm C. In 2006, Ivoclar Vivadent introduced a lithium disilicate ceramic called IPS e.max CAD that has the properties of a structural and aesthetic ceramic. In 2007, Sirona Dental Systems introduced CEREC Block, which is similar to Vitablocs Mark II but with a different shading nomenclature. The blocks are available in six shades and three degrees of colour saturation (chroma): translucent (T), medium (M), and opaque (O)[2][4]. The change from a two-dimensional design program to a three-dimensional (3-D) design program occurred as the speed and memory of computers improved [5].

IV. Aesthetic Ceramics

The principal features of aesthetic ceramics are that they have excellent translucency, contain a glass phase and have moderate strength. The glass component allows them to be etched and adhesively bonded to the tooth. The two feldspathic glass ceramic materials are: Vita blocs Mark II and TriLuxe blocks (Vident) which contain three different shade layers to re-create the shade and translucency of the tooth from cervical to incisal. TriLuxe blocks features a gradient of color with increased fluorescence and chroma in the cervical area [6].

The etching time and concentration of the etchant depends on the crystalline content of the ceramic. Conventional feldspathic ceramics are acid etched with 9.8% HF acid for 2 minutes, leucite-reinforced feldspathic ceramics with the same concentration for 1 minute, and lithium disilicates should be etched with a lower concentration HF (eg, 4.6%) for only 20 seconds. A silane coupling agent is applied after cleaning of any precipitates from the etched surface in an ultrasonic cleaning unit. After proper pre-treatment and bonding of the tooth surfaces, a composite resin luting agent is applied. Despite the low physical properties of feldspathic ceramic (porcelain), several clinical studies indicate excellent success. A 95% survival rate was found for chairside CAD/CAM feldspathic ceramic (VITABLOCS Mark II). Prognosis was influenced by restoration size, tooth location (premolars had greater success), and vitality (vital teeth had greater success [14].

V. Leucite-Reinforced Glass Ceramics.

Indicated especially for anterior crowns, posterior inlays and onlays, with increased strength compared with traditional feldspathic ceramics and high translucency. More recently, they were largely replaced by lithium silicate ceramics, which have better physical properties. Restorations on nonvital teeth revealed significantly higher ceramic fracture rates [14].

CEREC Blocs (Sirona)

They also produced in a multi-coloured block form. It has a three-layered structure with the bottom (cervical) layer having the highest pigmentation and lowest translucency and the top (incisal) layer possessing the highest translucency and lowest color intensity. Multicolour blocks offer an enhanced aesthetic result compared with conventional monochromatic blocks [6]. They have a biaxial flexural strength of around 407 MPa, they are considered the strongest silica-based ceramics in dentistry. Their crystalline phase consisting of lithium disilicate and lithium orthophosphate, which increases fracture resistance without negatively influencing translucency. These materials must be crystalized in a sintering furnace after milling. They can also be stained and glazed. In combination with a titanium base, these materials can be used for monolithic implant supported crowns. The special blocks for this indication have an appropriately sized hole to accommodate the Ti bases, which are resin bonded into the block.

IPS Empress CAD

It is offered in five colors, the block has a color gradient and translucency from cervical to incisal to simulate the transition of color and translucency in the natural dentition. Individual shade customization of either the monochromatic or multicolor blocks can be accomplished with the use of IPS Empress Universal Stains. Although IPS Empress CAD blocks and IPS Empress CAD Multi Block can satisfy most clinical conditions esthetically and functionally, there will be situations in which esthetics are requested or desired, with strength being a diminishing factor, particularly in the molar regions.

Paradigm C (3M ESPE)

It is a 30% leucite-reinforced glass-ceramic. Available in six shades. It is a radiopaque ceramic that exhibits a chameleon effect once seated in the tooth due to its enhanced translucency and fluorescence. The shade can be customized using the Lava™ Ceram (3M ESPE) stains and glaze [14].

VI. HIGH STRENGTH CERAMICS

IPS e.max CAD

It has a flexural strength of 360 MPa to 400 MPa. It provides opportunity to either etch and adhesively bond the material to the tooth or use a conventional cementation technique. The CAD/CAM block form is available in nine A-D shades, two translucencies, and four bleach shades [6].

Has enough glass content to provide translucency for aesthetics and acid-etching capability for bonding. It can be used as a translucent coping to which porcelain additions can be made, allowing for a wide range of clinical indications. IPS e.max CAD is milled in a precrystallized, intermediate-strength, lithium metasilicate crystal blue state to maximize milling functionality and material performance, all of its blocks originally are blue, regardless of the final shade chosen.

Therefore, its final strength at full crystallization and predetermined shade are achieved via a final 19-minute oven firing cycle, which originally was a 35-minute firing cycle. During this cycle, staining and glazing take place at the same time as the crystallization process. Its strength characteristics have been shown to be greater than those of zirconia crowns and porcelain-fused to-metal crowns [7].

Composite Resin Permanent Restoration

Paradigm MZ LOO (3M ESPE)

It is a polymer composite block based on the Z IOO composite chemistry using a processing technique to maximize the degree of cross-linking. It has zirconia-silica filler particles and is 85% filled by weight with an average particle size of 0.6 pm.

Composite can be more easily adjusted and polished intraorally compared to ceramic materials, which is an important feature of the chairside clinical technique because there is generally no working die and occlusal refinement occurs intraorally.

Composite Resin- Temporary Materials

Vita Cad-Temp* (Vident) is a highly crosslinked micro filled polymer that is available in extended block sizes, to accommodate multiple unit FPDs. It is offered as a monocolor block that comes in four shades or a multicolor form with four shade layers for more esthetic cases.

Telio®CAD (Ivoclar) was recently introduced as a millable cross-linked polymethyl methacrylate block for temporary crowns and EPDs. The block is part of the Telio system, which includes a self-curing composite, desensitizes and cement. Available in five shades. Both temporary materials are recommended by the manufacturers for up to 1 year of clinical service [6].

Polymethyl Methacrylate Based Materials

Crossed-Linked Pmma Cad/Cam Blocks, (Ivoclar Vivadent) are typically used for provisional restorations. Polymeric inlays have a marginal adaptation and fracture load values that are similar to glass-ceramic inlays. Newer developments, such as VITA CAD-Temp multicolour blocks offer increased physical and, through polychromatic layers of different shades and translucency levels, optical properties.

Ivoclar Vivadent

It has all the properties of the IPS Empress CAD block, but it is polychromatic.

It is layered by chroma and value, which mimics the polychromatic effect of natural dentition internally and eliminates the need for external application of surface stain. Milling unit is designed to shape the final restoration with minimal damage to the ceramic block by using an intermittent-touch process with a water-soluble lubricant under a constant water-cooled spray.

After retrieving the restoration from the milling unit, the dentist verifies the fit and uses surface finishing techniques to refine ceramic surface by creating a gloss that promotes a plaque-free surface. Once finishing is complete, the restoration is placed by using one of a variety of adhesive options, from total-etch to self-etch techniques [14].

Resin Matrix Ceramics

They are divided into 2 subgroups: 1) Resin-based ceramics 2) Hybrid ceramics.

Among their advantages compared with silica-based ceramics are higher load capacity, better modulus of elasticity, and favourable milling properties.

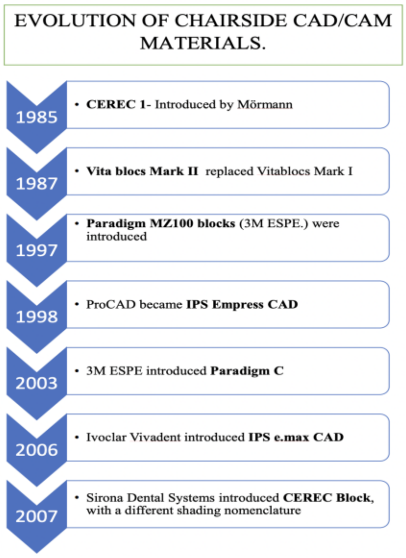
Oxide Ceramics

High-strength polycrystalline metal oxide–based CAD/CAM ceramics such as zirconium dioxide (zirconia) are characterized by excellent mechanical properties, which are significantly greater than those of silica-based ceramics. Flexural strength values of conventional yttria-stabilized tetragonal zirconia polycrystal ranges between 1000 and 1500 MPa.

The first generations of zirconia had only limited translucency and were, therefore, used for copings and frameworks that had to be veneered with a feldspathic veneering porcelain. Success rates were similar to porcelain-fused-to-metal restorations. The higher translucency is achieved by slight changes of the Y2O3 content (5 mol% or more instead of 3 mol%), resulting in a higher number of cubic-phase particles.

It offers significantly higher light transmission but lower flexural strength values than conventional zirconia. Some examples of high-translucent zirconia blocks for chairside CAD/CAM systems have recently entered the marketplace, such as CEREC Zirconia (Dentsply Sirona), Katana Zirconia Block (Kuraray Noritake Dental, Inc), VITA YZ (VITA Zahnfabrik), Lava Zirconia Block (3M ESPE), and IPS e.max ZirCAD (Ivoclar Vivadent) [7].

CEREC AC



The most recent evolution, the CEREC Acquisition Center unit, has introduced a newly developed light-emitting diode (LED) camera called the Bluecam. It is based on a blue LED that replaces the infrared-emitting camera in the CEREC Acquisition Unit [13]. A light film of reflective powder is applied to the surfaces in preparation for their being recorded with a new blue spray film developed by Sirona Dental Systems that is optimized for use with the blue wavelength light. The powder can be applied quickly and lightly, it can be rinsed easily with water, and it does little to contaminate the operating field. The shutter will not release until the system applies image stabilization automatically and the tooth to be scanned is within the shutter's extended focal range of 14 millimetres and blur free. The deep, 14-mm focal range permits the camera to rest on the tooth if needed to allow access to tight distal molar regions, while keeping the image in sharp focus from the tips of cusps to the preparation margins. Once this image is obtained, the dentist can move the camera mesially or distally to obtain images of the next tooth needed to construct the virtual model. Restoration proposals generally require minimal editing, and the dentist can design most restorations successfully in five to seven minutes by using a proprietary biogeneric database that creates tooth forms specific to the needs of the patient.

It also involves the use of a negative image of a bite registration material to produce a virtual working opposing model, thereby eliminating the need to scan the opposite arch separately. The second is by scanning both arches separately and then acquiring a third scan with both arches in a closed, centric position. Dentist needs to consider the factors of value, hue and chroma, in that order. If they are prepared properly, most low-translucency (IPS Empress CAD LT, Ivoclar Vivadent) or high-translucency (IPS Empress CAD HT, Ivoclar Vivadent) blocks available in standard Vita A, B, C and D shades (Vident, Brea, Calif.) can blend effectively with existing enamel and dentin to create an even dispersion of light much like that of natural tooth structure, owing to their leucite glass content.

VII. Properties

Fracture Toughness of Chairside CAD/CAM Materials:

Fracture toughness (KIC) is an intrinsic property of a material that relates to its resistance to crack propagation which finally causes its failure. This property is concerned with the critical stress intensity, K, at the crack tip. The critical stress intensity depends on the tri-axial strain conditions and crack instability that occurs under plane strain conditions at a minimum K to be referred to as fracture toughness (KIC). A restorative material with high KIC shows better fracture resistance and longevity in service as compared to materials with lower KIC.

According to Badawy R. et al., highest KIC values were recorded for fired/crystallized glass-ceramic materials (Celtra Duo/E-max, respectively). Glass-ceramic materials without firing or crystallization were associated with significantly lower mean KIC compared to their fired/crystallized counterparts [17].

Hampe R. who evaluated and compared the fracture toughness of dental CAD/CAM materials of different material classes intended for in-office milling (glass ceramics, hybrid, resin composites) and the influence of aging on this property came to a conclusion that the materials tested showed differences in fracture toughness typical for the class they belong to. With one exception (Ambarino High-Class), thermocycling affected the fracture toughness of materials with a resin component negatively, whereas the leucite and lithium disilicate ceramic showed stability [22].

Impact Of Toothbrushing on Surface Properties of Chairside CAD/CAM Materials

CAD/CAM composite plastic-based materials have a low modulus of elasticity which allows them to absorb stresses and decrease susceptibility to fracture and chipping. They are fabricated by polymerization at high pressures and temperatures, which improves their mechanical properties, generating a more homogeneous and less porous material compared to conventional resin composites. Restorations made with these materials can be machined in less time and repaired more easily than ceramic restorations. Abrasive particles in toothpastes can increase surface roughness and decrease gloss, affecting the aesthetic quality and longevity of a restoration. It has been observed that composites with TEGDMA, UDMA and Bis-EMA containing a glass phase (ENA and EMP) presented higher wear resistance, higher gloss, and lower roughness after brushing than the other materials tested [18]. The surface roughness plays a role in bacterial adhesion and retention. Biofilm can develop when the attached microorganisms start to colonize and remained attached, which can lead to carious development and periodontal inflammation [24].

Coronel Abad C. et al., evaluated materials such as Cerasmart Shofu Block HC (SBH), Tetric CAD (TEC) and Brava (BRA), all the tested materials exhibited mass loss [18].

Schmitt G. et al., came to a conclusion that the materials containing a glass phase (ENA and EMP) presented higher wear resistance, higher gloss, and lower roughness after brushing than other material tested [27].

Edge Strength of CAD/CAM Materials

Marginal wear and load transfer to the margins may cause loss of the cement and leave the margins of the restoration without support. The margins should not be located under direct loading to reduce margin fractures and adhesive bonding may be used to improve marginal strength and quality. Minor chipping seems to result in reduced aesthetics and increased marginal staining. Bigger fractures might even cause enhanced tooth sensitivity, plaque accumulation, or microleakage and might result in secondary caries. Insufficient preparation or fit, due for instance to the radius of the milling tool, may exacerbate these effects. Repeated chewing forces on a material with low elasticity or low edge stability may cause spreading or fracture of the margins and finally debonding. Edge force tests may allow for the characterization of the stability of a restoration at the margin Fracture and chipping are supposed to be influenced by the distance from the edge, the thickness of the restoration, the type of intender, and bonding to the underlying (tooth) structure. Feilschifter M. et al., have concluded that Brilliant Crios, Enamic, Shofu Blocks HC, and Grandio Bloc showed significantly different edge force between the 1-mm- and 2-mm-thick plates. The failure pattern was either cracking, (severe) chipping, or fracture [13].

According to Katsuhito K. et al., LiSi Block as a new lithium disilicate glass ceramic block has high chipping resistance and is a useful restorative dental material for single-visit treatment. They suggested that the fine and high-density crystals of LS can stop crack growth and increase the edge chipping resistance [23].

Polishing Effects and Wear Performance of Different CAD/CAM Materials

To guarantee long-term clinical success, all materials should be sufficiently smoothed. Smooth and polished surfaces support the esthetic appearance of dental restorations, minimize bacterial adhesion, minimize fatigue and chipping or fracture, and improve flexural strength. Smooth surfaces undergo less wear and therefore extend the longevity of a restoration. However, the effects of surface manipulation (e.g., polishing, wear) are strongly dependent on applied parameters (e.g., pressure, temperature, type of drill) and properties of the material itself.

Matzinger M. et al., reported, roughness data after chairside and lab side polishing procedures were comparable, although surfaces were directly adjusted (roughened) only before chairside polishing. Ceramics exhibited lower mean wear than resin composites, but ceramics displayed higher antagonistic wear [19].

According to Çakmak G. et al., surface treatment and material affected the surface roughness and microhardness of materials, and polishing resulted in higher surface roughness and microhardness than glazing and the volumetric loss of CAD/CAM materials and the height loss of the enamel antagonist were affected by the material. Surface treatment (glazed or polished) had no effect on the volumetric loss of materials or enamel antagonists also, there was no correlation found between the wear behavior of materials and the enamel antagonists or the surface roughness of materials and the volumetric loss of materials or antagonists.Polished groups had higher surface roughness before the wear test, glazing or polishing had no effect on the wear of the material or its antagonist [20]. Manual finishing and polishing for 60 seconds and glazing paste were one of most effective procedures at lowering the roughness of CAD-CAM silica-based glass ceramics. It allowed milled silica-based glass ceramics to yield the highest gloss [25].

Measurement Of Elastic Constants of Chair Side CAD/CAM Materials

Elastic constants are a set of constants, also known as elastic moduli, that defines the properties of material that undergoes stress, deforms, and then recovers and returns to its original shape after the stress ceases. The elastic constants include the bulk modulus, Poisson's ratio, shear modulus, and Young's modulus. Materials under mechanical stress deform, resulting in changes in their original volume and shape. Elastic properties are mainly dictated by the microstructure and material composition.

Belli R. et al., have concluded that the measurement of elastic properties depends on the accuracy of the method employed. Higher value for Poisson’s ratio is observed for the zirconia ceramics e.max ZirCAD and the glass ceramics e.max CAD, whereas it was lower for the Feldspar-reinforced aluminosilicate glass Vitablocs Mark II. Enamic shows a young’s modulus approximately three-fold higher compared to Lava Ultimate. In case of stress distribution and effect of elasticity on dental crowns, the distribution of stress does not depend on the bite force. When the load increased, the maximum stress and this effect was more pronounced for a polymer-matrix composite than for a glass–ceramic [26].

Staining & Aging Dependent Changes in Color Of CAD/CAM Materials

Surface finishing procedures have been reported to affect surface texture and roughness with higher surface roughness correlated with increased plaque retention and difficulty in cleaning. These factors are associated with coloured beverage consumption, such as coffee, wine, and tea, and with material aging affect the color stability of restorations. Stamenkovic D. et al., evaluated staining, aging, and the exposure interval on color changes of computer-aided design and computer-aided manufacturing (CAD/CAM) resin nanoceramics

(RNC), polymer-infiltrated ceramic-network (PICN) materials, lithium silicate and lithium disilicate ceramics, came to a conclusion that no difference was found in color stability among laboratory and chairside polished specimens. Coffee caused the greatest color changes for T0-T2 interval. Staining-dependent color differences increased with increased exposure, except for IPS e.max and Vita Suprinity. For artificial aging, color change appeared to be material dependent [16].

According to Gasparik C. et al., greatest color changes due to staining were observed for Lava Ultimate while the lowest for e.max CAD. Both coffee staining and bleaching induced greater color changes for HT materials of the same brand compared to LT [21]. Significant differences in color stability were recorded between resin-based materials and lithium silicate based and lithium disilicate based materials on coffee and red wine staining. Among all, ceramics based on lithium disilicate or feldspar which are highly dense materials showed the best color stability [21]. Polymers uptake water and therefore may be more prone to absorbing the pigments of staining solutions [16].

Future Perspective

Restoring a patient's quality of life (QOL) through dental service is becoming more and more important to fostering the health of people in an aging society [2]. One limitation of current CAD/CAM systems is their inability to incorporate esthetic veneers with strong (but relatively unesthetic) cores and frameworks [5]. Lasers have been shown to sinter translucent veneering silicate ceramics after they have been applied to a core using a plotter system and direct shell production casting. Structural design analyses during CAD process are promising and is expected to be a powerful tool for the design of dental ceramic frameworks of FPDs including the design of the connecting area to decrease the risk of fracture during function [8].

The analysis of multiple-axis mandible movements for the purpose of recovering oral function of patients has already been widely investigated in prosthodontics. In addition to the successful application of CAD/ CAM technology to the fabrication of FPDs, CAD/ CAM technology is also expected to be applied for the fabrication of removable partial denture frameworks, orthodontic devices and implant superstructures [2]. Additionally, dental CAD/CAM should also be available in educational settings and as training tools for daily dental practice, with explanatory materials for patients, diagnostic materials, and for simulations of surgical procedures. Data pertaining to the prepared, adjacent and opposing teeth could be sent directly to a CAD/CAM system without being interpreted by a technician or clinician. Likely enhancements may include a simpler user interface and integration of virtual articulators, which would facilitate automatic design of the occlusal surface. Femtosecond lasers have been introduced for cutting dental materials, including zirconia-based ceramics.

Direct shell production uses a rapid prototyping process similar to selective laser sintering to create ceramic investments in the shape needed, without a wax pattern. rapid prototyping approach that has shown much promise is direct-write assembly. With this system, the material from which the part is made is incorporated into special inks. The ink is delivered through specialized nozzles along the "tool path," defining the designed restoration to create the complex 3-D part. As the ink leaves the nozzle, it freezes instantaneously into the desired shape; however, for high-strength parts such as ceramic dental restorations, the materials need to be made denser [8]. In the future, practical application of these technologies to dentistry may provide unexpected paradigm shifts in fabrication approaches and materials options. As more scanning and fabrication technologies are introduced to fabricate restorations, it is likely that more cooperative networks and open systems will be used. [8]

VIII. Conclusion

The evolution of current systems and the introduction of new systems demonstrate increasing user friendliness, expanded capabilities, and improved quality, and range in complexity and application. Current intraoral scanning technologies are as accurate as, or even more accurate than, conventional impression techniques, at least for single or short multiunit restorations, and more comfortable for the patient. Most of the modern materials fabricated in the laboratory can also be fabricated chairside in a single visit, from PMMAs to composite resins and various types of ceramics with excellent clinical long-term success [1][2][5]. The outcome of the clinical treatment is strictly related to the attention paid to choosing the unique properties and features of the various categories of CAD/CAM materials. The success of chairside restorations depends on several factors such as material selection, restoration design, occlusion, and cementation [15]. To date, clinical studies have documented the predictability and longevity of chairside CAD/CAM restorations [5]. An examination of material properties should lead us to select those systems engineered to provide the patient with the best clinical outcome with respect to esthetics, function, longevity and compatibility with surrounding natural tissues. Analysis of clinical and laboratory data demonstrates that machined restorations are a reliable, aesthetic alternative that may provide a superior outcome relative to conventional fabrication systems [12].

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