REVIEW ARTICLE

# CAD - CAM in Pediatric Dentistry: A brief insight

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## ABSTRACT

On introduction of computer aided technology/ computer aided manufacturing in pediatric dentistry, treating children has become effortless, mainly children with special health-care needs. This technology aims at the fabrication of restorations with higher strength and better aesthetics by an effortless, quicker and more precise operational process. This technology has proved to be a boon in various fields in pediatric dentistry. The latest trend of minimally invasive dentistry, relies on selective caries removal and restoring it with material which is highly adhesive and aesthetic. CAD-CAM makes use of an optical impression of the required area and occlusion which is taken using hassle-free intra-oral scanners. Machinable high strength composite/ ceramic blocks are used which can be polymerized under pressure and temperature. The CAD-CAM technology has its advantage of needing less chair side time, brisk production of restorations with increased precision, eliminating the need for classic methods of impression, high strength and aesthetic restorations and prostheses. CAD-CAM technology can be used for smile designing in patients with developmental defects like Amylogenesis Imperfect, Molar-Incisor Hypo mineralization, etc., prosthetic rehabilitation in patients' requiring stainless steel crowns and zirconia crowns, restorative procedures like inlays and onlays, naso-alveolar molding etc. Thus, it opens up a sea of possibilities for providing a high quality of treatment for the child with minimal\ hassle and maximal benefits to the child.


## INTRODUCTION

The creation of new biomaterials has advanced quickly and is still progressing quickly. New production techniques and treatment paradigms have emerged as a consequence of ongoing improvements in software and hardware of the computer, posing a considerable challenge for dentists who strive to stay on the cutting


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edge of dental technology. With the introduction of CAD/CAM (Computer-aided design/computer-aided manufacturing), dental offices and labs can now use computers to design and create aesthetically pleasing and long-lasting restorations.

The first CAD/CAM device was created by Dr. FrancosisDuretin 1971. He used an optical impression of the abutment tooth and a numerically controlled milling machine to fabricate crowns [1]. In 1983, he created the first CAD/CAM dental restoration. In 1983, Dr. Anderson invented the Procera Method, which uses CAD/CAM to produce high-precision dental crowns [1]. The Sopha system was created by Dr. Duret in 1984 [2]. The Chair-side Economical Restoration of Esthetic Ceramic (CEREC)system, which was the earliest system which combined the milling unit and digital scanning, was developed in 1987 by Mormann and Bran Destini [1,3].

The invention of CAD/CAM in dentistry has made treating uncooperative children and those with special health-care needs effortless. Utilising less chair side time, brisk production of restorations with increased precision, eliminating the need for classic methods of impression, high strength and aesthetic, metal-free restorations are the foremost advantages of CAD-CAM technology.

COMPONENTS OF CAD-CAM TECHNOLOGY

All CAD-CAM systems have three elements:

1) Digitalised scanner for optical impression
2) Software
3) Production technology scanner

1. <u>OPTICAL/DIGITAL IMPRESSION-</u>

Digital impression is made using intra-oral scanners which are small, hastle-free and doesn't produce any discomfort to the patient. These scanners record a series of snapshots of that particular structure or tooth which are transferred to the computer where the image gets processed and a virtual model is obtained. The receptor unit and the light source (such as

a laser) are at a clear angle to one another.

Through this angle, the figure produced on the receptor unit can be used to generate a 3D data set by the computer [4].

E.g.- Lava Scan ST(3M ESPE), Everest Scan (KaVo,white light projections) and es1(etkon, laser beam).

2. <u>DESIGNING SOFTWARE-</u>

Processing devices can be divided into three categories based on the number of milling axes [5]:

1) 3-AXIS MILLING DEVICE-

This kind of measuring tool can move to varying degrees in three spatial directions. The three axes of control on these milling machines make for quick milling times and easier control. As a result, these milling machines are typically less expensive than ones with more axes.

Eg. -Lava (3M ESPE), Cerconbrain(Degu dent).

2) 4-AXIS MILLING DEVICE-

The component's tension bridge can be rotated in addition to the three spatial axes (4 axis). It helps to save material and milling time by allowing bridge designs with significant vertical height displacement to be adjusted inside the typical mould dimensions.

E.g.-Zeno(Wieland-Limes).

3) 5-AXIS MILING DEVICE-

There is also the option of rotating the miling spindle in addition to the 4-axis (5 axis). As a result, intricate designs with subsections can be milled, such as lower jaw FPDs on converging abutment teeth.

E.g.-Everest Engine (KaVo).structures.

3.PRODUCTION TECHNOLOGY – (Beuer F. 2010)

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| CERCON | It does not include a CAD element. A minimum thickness of 0.4 mm wax pattern i.e coping and ponticis created using this technology. A zirconia bridge coping is milled from pre-sintered zirconia blanks after scanning the wax design. Hereafter, the coping is sintered for 6 to 8 hours in the Cercon heat furnace (1,350C). |
| EVEREST | It is made up of them, engine, and scan components. A gypsum cast (which is reflection-free) is attached to the turntable in the scanning unit, and a CCD camera scans it in a ratio of 1:1 with a 20 m measurement accuracy. Its 5-axis-moving machining unit can produce intricate morphology and accurate margins from a range of materials. |
| LAVA | Tetragonal zirconia poly-crystals stabilised with yttria are used in this system. (Y-TZP), which are more resistant to fracture than traditional ceramics. |

| | |
|---|---|
| CEREC SYSTEM | Restorations are electronically designed and milled using the CEREC (computer-assisted Ceramic Reconstruction) CAD/CAM technology. |
| E4D DENTIST SYSTEM | Aside from CEREC, same-day in-office restorations is enabled by this method only. This system consists of a milling unit, a design centre, and a laser scanner (Intraoral digitizer). The scanner is positioned close to the target tooth and is held at a certain distance from the area being scanned by two rubber feet. |

APPLICATION OF CAD-CAM IN PEDIATRIC DENTISTRY

1. Nasoalveolar molding (NAM) appliance fabrication

In individuals with cleft lip and palate (CLP), Nasoalveolar Molding (NAM) is a presurgicalorthofacial procedure that tries to achieve nasal symmetry via a nasal stent. It aids in the approximate alignment of the alveolar segments and increases nasal symmetry in the initial phase of therapy. The latter typically begins in the period when the columella lengthens and the nose on the cleft side develops (second half of the therapeutic period). The nasal stent needs to be installed onto a new plate when plates need to be changed due to dentoalveolar growth or cleft reduction. For patients and parents, this process extends visiting hours or necessitates more treatment appointments. For chairside nasal stent interchange, RAPID NAM has been introduced, which incorporates a quick-lock additive manufacturing technology. a unique tape retention pin. Since the pin on every RapidNAM-plate is the similar size, a prior fitted nasal stent can be detached and shifted to the following plate simply unwinding the screw. The ripid-lock system for CAD/CAM-NAM equipments combines additive manufacturing and conventional NAM. NAM for CAD/CAM and its improvement Rapid NAM dramatically raised the nasal height on the cleft side and tipped the nose in the direction of symmetry. Since the pre-existing stent can be reused, the quick-lock device minimizes wire adjustments. This brand-new nasal stent device combines CAD/CAM technology with classic NAM components [6,7].

2. Congenitally missing teeth

Premolars are the second-most frequent permanent teeth to be born without. If there is no clear evidence for extraction, one of the therapeutic options is to keep the deciduous molar for upcoming implant surgeries. Since the deciduous molar's mesiodistal diameter is larger than the premolar's, it is advised to lower the retained tooth's mesiodistal breadth. This will enable the minor space left after the extraction of the deciduous molars to close on its own by mesial drifting of the teeth next to it. Nevertheless, mesiodistal reduction leaves the tooth with dentinal exposurewhich is susceptible tocavities. As a preventative precaution, restoration of the exposed dentin with composite is advised. However, composite repair implies a long-term danger of minor leakage and colorization. The restoration process offered by CAD/CAM reduces the probability of human error while producing highly appealing results. To improve function and aesthetics, a second primary molar that is still in place can be reshaped utilising resin nanoceramic CAD/CAM technology [8,9]. In case the retained tooth is anticipated to preserve functioning over the long term, despite the high expense of treatment, this should be the preferable option. Comparing resin nanoceramic blocks to ceramic restorations, they have improved mechanical qualities such asreduced abrasive property of the opposing arch and anincreased level of monomer polymerization. If necessary, they can also be easily repaired using composite resin. Full ceramic restorations are popular for their aesthetic benefits, but resin nanoceramic restorations also produce beautiful aesthetic results. Because of this, a primary second molar in the present scenario is often reshaped using a CAD/CAM Cerec block to approximate the structure of a permanent second premolar [10].

3. Stainless Steel Crown

To prolong the life of the tooth, pre-formed stainlesssteel crowns are typically implanted in primary molars following pulp treatment or in conjunction with multi-surface caries. Alternatives that are more intrusive but offer better aesthetics include zirconia crowns. For treatment of deep and extensive caries on primary molars, CAD/CAM technology is now being applied [11]. Onlays manufactured using CAD/CAM technology fit the tooth preparation flawlessly, in comparision to pre-formed crowns. The luting quality improves as a result of the thinner bonding material layer [12]. The CAD/CAM-made onlays are sturdy mechanically and aesthetically [12]. Composites produced with CAD/CAM are machined from highly polymerized materials with the least amount of monomer release. The suggested method of tooth preparation can be used by pediatric dentists without any special training. When treating young children, it significantly shortens the implementation time. Additionally, a single chairside session can be used to create the restoration employing a CAD/CAM system. Therefore, these composites are more biocompatible as compared to stainless steel (NiCr) crowns [13]. Additionally, CAD/CAM composites are less prone to erode the teeth in the opposing arch and wear down than ceramic crowns [14]. Aesthetic CAD/CAM block materials comparable to or superior than human enamel in terms of toothbrushing and two-body wear. Ceramics have the unmatched gloss retention when compared to acrylic polymers, hybrid ceramics and composites. Due to their improved wear resistance and glossiness, these materials have a lower propensity to retain plaque [15].

4. Restoring Congenitally Malformed Teeth

A genetic condition known as amelogenesis imperfecta changes the structure of enamel, which has an impact on young patients' function, appearance, and psyche [16]. With the use of polymer-infiltrated ceramics, a child's dentition can be restored with little tooth preparation [17]. Because of its prosthetic design software, optical impression systems, and restoration milling equipment, in-office CAD-CAM systems have gained popularity. Materials for polymer-infiltrated ceramic networks (PICN) are provided as monolithic blocks for CAD-CAM milling. At a minimal thickness of 0.3 mm, this material exhibits exceptional fracture resistance, protecting tooth substance while preserving acceptable mechanical qualities. However, assessing whether the hue will stabilise requires long-term monitoring. The PICN material can be adjusted by mixing in composite resin after the patient has achieved his final growth period. These permanent restorations would greatly enhance the patient's aesthetics through his youth and adolescence without tooth tissue loss [18].

5. For Special Health Care Children

It might be difficult to care for kids who have unique medical requirements. Long chairside oral care is sometimes hampered by communication issues and side effects related to their various conditions (physical disability,mental retardation, visual, hearing ormotor, impairment etc.). Utilizing CAD/CAM technology, veneer preparation for traumatized teeth is less intrusive, requires less chairside time, and is more pleasant for the subject. Additionally, impression taking in CAD/CAM is quicker, and powdering is not necessary for modern equipment. Patients, mainly those with gag reflexes, tolerate it significantly better. Additionally, its quality is superior than or on par with that of a traditional impression. The greatest option in terms of durability, aesthetics, and cavities prevention is ceramic veneer using CAD/CAM [16].

6. Space Management

A common consequence of unresolved dental caries where the damage is beyond repair is the premature extraction of deciduous teeth. Premature extraction may result in malocclusion in the permanent teeth due to lack of room for the succeeding tooth, tooth movements, and loss of arch integrity. To encourage the proper functional occlusiondevelopment in children until the subsequent permanent tooth erupt, fabricated space maintainers are provided post extraction. By doing this, the available space is preserved. In comparison to the traditional band and loop space maintainer, the ceramic onceappears to be a good choice [17]. It has advantages over metallic space maintainers in that it is highly durable thanks to its monolithic design, does not cause gingival trauma or lacerations because band pinching is not necessary, does not cause nickel allergies or corrosion, and prevents teeth from tipping over because there is tooth support on both sides. The patient tolerates the device well, and it also offers better strength and advanced aesthetics [18].

7. OSA (Obstructive sleep apnea)

Children typically experience obstructive sleep apnea, a common but treatable disease [19]. Periods of partial or total airway restriction during sleep, which causes hypoxia or fragmented sleep and has substantial clinical repercussions, are the hallmarks of the disease. The palatal and gingival tissues, as well as the teeth, all showed excellent compatibility with the sleep apnea device. Free anterior and posterior movements were possible due to the hinges [20]. The hinges also allowed for some sideways mobility. Although more research might be done to lessen this, there may be a case for keeping this movement in place to keep the device myodynamic.

## CONCLUSION

To preserve and restore oral functioning, the dentist must give each patient high-quality dental treatment. Therefore, implementing cutting-edge techniques and materials, including digital impressions (created with a CAD/CAM system), is crucial for future oral health procedures. Although it has several uses in paediatric dentistry, there is a higher learning curve involved.

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### Conflict of Interest

The authors declare no conflicts of interest regarding the publication of this article on CAD-CAM in Pediatric Dentistry.

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All relevant data are included in the article or available upon request from the authors.

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