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# 3D Printing and Its Emerging Role in Pediatric Dental Set Up -A Review Article

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***Abstract***
*Three-dimensional (3D) printing, also known as additive manufacturing, has revolutionized modern dentistry by enabling precise, customized, and efficient treatment solutions. In pediatric dentistry, its application has expanded rapidly, offering innovative approaches in diagnosis, treatment planning, and appliance fabrication. Interceptive orthodontics plays a crucial role in guiding the proper development of occlusion during the mixed dentition stage. The integration of digital technologies into pediatric dental practice has significantly enhanced the efficiency, accuracy, and predictability of interceptive orthodontic procedures. Digital tools such as intraoral scanners, cone beam computed tomography (CBCT), computer-aided design/computer-aided manufacturing (CAD/CAM), and three-dimensional (3D) printing have transformed conventional approaches into streamlined digital workflows. This review aims to illustrate the concept of digitally driven interceptive orthodontics in pediatric dentistry and its application in routine clinical practice, along with its advantages, limitations, and future scope.*
***Keyword:*** *3D printing; Additive manufacturing; Dental technology advancements; Digital dentistry; Pediatric dentistry*

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## I. Introduction

3D printing, also known as additive manufacturing, is an advanced digital technology that fabricates three-dimensional objects layer by layer using computer-aided design (CAD) data. In dentistry, this technology has rapidly transformed conventional clinical and laboratory procedures by enabling precise, customized, and efficient fabrication of dental appliances and restorations. In the Dental technology advancement the integration of intraoral scanning, CAD/CAM systems, and 3D printing has significantly improved accuracy, reduced chairside time, and enhanced patient comfort.

In pediatric dental setups, 3D printing is emerging as a valuable tool due to its ability to produce child-specific dental models, space maintainers, crowns, orthodontic appliances, surgical guides, and educational models with high precision and faster turnaround time. The technology also improves communication with children and parents through visual demonstration models, thereby increasing treatment acceptance and reducing anxiety. Additionally, digital workflows minimize material wastage and allow easy storage and reproduction of patient records. Introducing in-clinic CAD-CAM in pediatric dental setup enhances digital workflow, enables same-day restorations, improves accuracy, comfort, esthetics, and efficiency.

With continuous advancements in biocompatible materials and printing techniques, 3D printing is becoming an integral component of modern pediatric dentistry. Its growing applications highlight the potential to deliver minimally invasive, accurate, and patientfriendly dental care for children.

## II. Three Dimensional printing workflow in Pediatric dental setup.

The 3D printing workflow in dentistry streamlines clinical care by transforming digital scans into physical, patient-specific appliances via step process:

Data Acquisition (Scanning)

Digital CAD Design



Additive Manufacturing (Printing).


**2.(1) The Data Acquisition (Scanning) the intraoral scanner is widely used in the setups**
Gradually as the technology evolved the generation of the scanner kept advancing in the market.
Generation of intraoral scanner
There are various types of Intraoral Scanner Companies
(1st → Latest Generation – Used in India)

1st Generation (Early CAD/CAM – Powder-based, bulky)
- Dentsply Sirona → CEREC (early versions)
- 3M → Lava C.O.S

2nd Generation (Improved optical scanners)
- Align Technology → Early iTero
- Carestream Dental → CS series (early)
- Planmeca → PlanScan

3rd Generation (Modern digital scanners – widely used in India)
- 3Shape → TRIOS 3 (2015)
- Medit → i500 (2018)
- Carestream Dental → CS 3600
- Align Technology → iTero Element

4th Generation (Latest / Advanced – currently used in India)
- Dentsply Sirona → Primescan (2019)
- 3Shape → TRIOS 4 / TRIOS 5
- Medit → i700 (2022)
- Align Technology → iTero Element 5D
- Shining 3D → Aoralscan 3

Indian / Budget Market (Used in India – based on 3rd/4th gen tech)
- Waldent
- Orikam

**2.(2) Digital CAD Design**
Digital CAD (Computer-Aided Design) in dentistry uses specialized software to create precise 3D models of dental structures from digital scans, replacing traditional messy impressions.
Common Software Platforms: Specialized software (like 3Shape TRIOS, CEREC) is used for designing, including specialized software training for dental technicians and dentists

**2.(3) Manufacturing (Printing).**
3D printing in dentistry (Digital Dentistry 4.0) enables in-house production of accurate dental models, surgical guides, aligners, myofunctional appliances, and crowns using SLA/DLP technology.
Popular printers range from the high-accuracy Phrozen Sonic XL 4K for clinics to compact units like the Elegoo Saturn 3 Ultra .Most commonly used Dentsply Sirona CEREC .
The workflow involves scanning, designing, printing with biocompatible resins, and post-processing .

## III. Applications of 3D printing in Pediatric Dentistry

Digital technology has become an essential component of modern dental practice. Over the past few years, 3D printing technology has rapidly expanded across various branches of dentistry due to its wide range of applications and clinical benefits. Its use has become especially prominent in oral and maxillofacial surgery, prosthodontics, and orthodontics, where 3D-printed devices and restorations are increasingly being preferred over traditional methods. However, despite its growing popularity, the application of 3D printing in pediatric dentistry remains relatively limited and requires further exploration.

Treating pediatric dental patients can be challenging because children often experience fear and anxiety during dental procedures, resulting in limited cooperation compared to adults. Therefore, pediatric dentistry continues to evolve toward more child-friendly, efficient, and minimally invasive treatment approaches that address the specific needs of young patients. Among recent technological innovations, 3D printing has emerged as a promising tool in pediatric dentistry. Due to its high precision and accuracy, this technology allows for less invasive procedures and can significantly reduce chairside treatment time, which is particularly beneficial when managing pediatric patients.

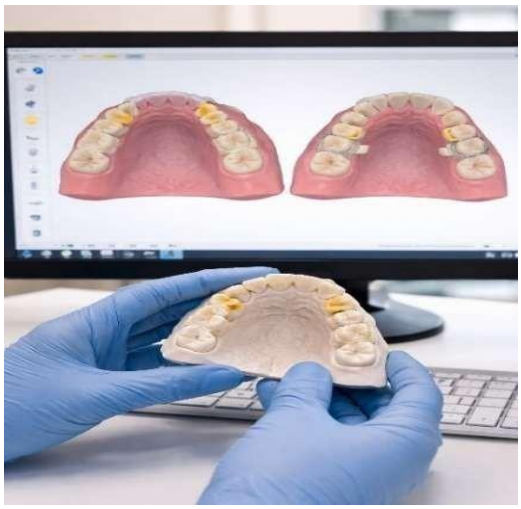
**3.(1)Models**

With the increasing use of intraoral scanners, many dentists choose to create a 3D-printed master model of the scanned dental arch. Although fabrication of a physical master model is not always essential, clinicians often prefer it because they are more accustomed to evaluating restorations on a tangible model, even when restorations are produced through a completely digital workflow.

In addition, digital storage of patient scan data enables models to be printed whenever required, thereby reducing the need for extensive physical storage space.

3D printing in dentistry is used to fabricate accurate dental models from digital intraoral scans. These models are commonly used for:

- Guidance of Eruption
- Orthodontic study models
- Surgical guides
- Crown and bridge planning
- Evaluation of space maintainers



Various materials are used for fabrication of 3D printed models

- Resin-based photopolymers are the most commonly used materials because of their high accuracy, smooth surface finish, and excellent detail reproduction in study models, orthodontic models, surgical guides, and prosthodontic work.

- Thermoplastic materials such as polylactic acid (PLA) and acrylonitrile butadiene styrene (ABS) are mainly used in fused deposition modelling printers for educational and demonstration purposes because they are economical and easy to print.

- Nylon materials are used where flexibility and durability are required, such as denture frameworks and orthodontic appliances.

- In advanced digital dentistry, ceramic-filled hybrid resins and biocompatible materials are also used to improve strength, aesthetics, and clinical performance of dental models and restorations.

**3.(2) 3D Printed Crowns**

3D printed ceramics in pediatric dentistry are used for fabrication of esthetic crowns. Ceramic materials provide high strength, durability, excellent esthetics, and biocompatibility, making them suitable for restoring primary teeth and improving digital pediatric dental treatment outcomes.

Types of Crowns Made by 3D Printing in Pediatric Dentistry

a) Aesthetic crowns

i. Resin-modified ceramic (RMC) crowns -Hybrid restorations combining porcelain aesthetics with composite resin flexibility, ideal for single-unit dental, anterior, or implant-supported cases

ii. Composite Crowns- Tooth-colored esthetic restorations commonly used to restore severely decayed or traumatized primary anterior teeth.

iii. Zirconia Crowns- Strong and highly esthetic ceramic crowns for primary molars and incisors

There are Monoblock zirconia crowns and multilayered zirconia crowns.

Monoblock zirconia crowns provide superior strength and durability using a single zirconia layer, whereas multilayered zirconia crowns offer enhanced esthetics, translucency, and natural shade gradients for pediatric restorations.

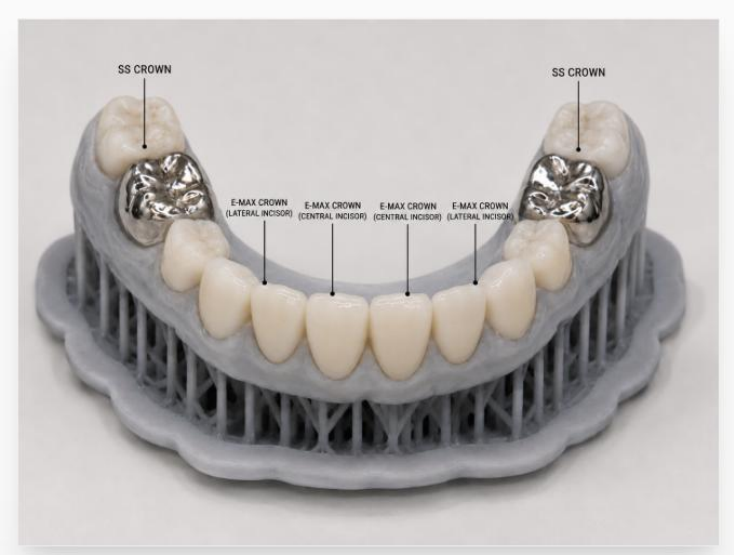
iv. Emax crowns- high-strength, all-ceramic dental restorations made from lithium disilicate, offering superior aesthetics and a natural, translucent appearance that mimics real teeth.

b) Metal Crowns

Examples

- Stainless Steel Crowns (SSC)
- Cobalt-Chromium Crowns
- Nickel-Chromium Alloy Crowns
- Laser-Sintered Metal Crowns
- Hybrid Metal-Ceramic Crowns
- Titanium Pediatric Crowns

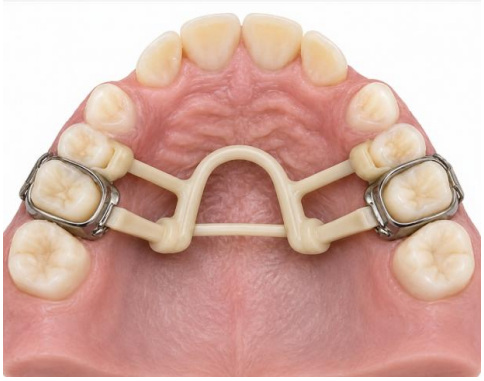
Digital patterns used for fabrication and customization of pediatric crowns




**3.(3) Fabrication of Space Management**

In pediatric patients, premature loss of primary teeth can lead to loss of arch space and future malocclusion. Digital dentistry allows precise space analysis using virtual models obtained from intraoral scanning.

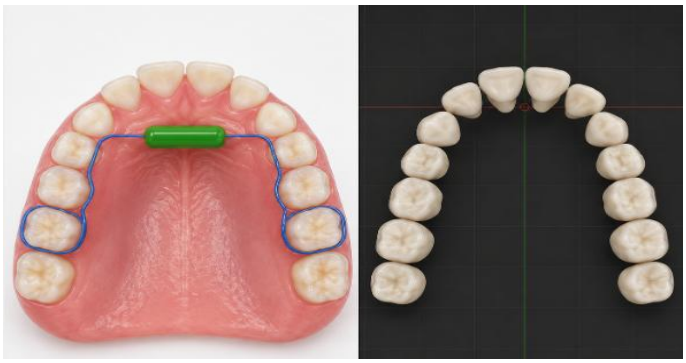
Based on this, customized space maintainers can be designed using CAD software and fabricated through 3D printing or milling. These appliances offer superior fit, better
comfort, and reduced chances of failure compared to conventional appliances.



Additionally, digital records help in periodic monitoring of space changes over time.
The integration of 3D digital dentistry with advanced biomaterials like PEEK (Polyether Ether Ketone) has significantly improved the precision, customization, and clinical outcomes of space-maintaining appliances. They offer significant advantages, including improved aesthetics, absence of metallic taste or allergic reactions, and better patient acceptance.

**3.(4) Interceptive Orthodontics in Pediatric Dentistry**
3D printing has been used in the creation of various interceptive orthodontic appliances, including brackets and clear aligners. It has been reported that 3D printing applications will be significantly beneficial in the fields of early orthodontic applications

A) Habit-Breaking Appliances
Oral habits such as thumb sucking, tongue thrusting, and lip biting can adversely affect occlusion and jaw development. With digital technology, habit-breaking appliances can be accurately designed according to the child's oral anatomy.
This customization improves appliance effectiveness and patient acceptance. Digital simulations also help in explaining the need for such appliances to both the child and parents, enhancing cooperation.



B) Arch Development
In cases of developing crowding or narrow arches, early intervention is necessary to guide proper jaw growth. Digitally designed appliances such as expanders allow controlled and precise arch expansion. The use of CAD/CAM ensures that these appliances are tailored to the patient's anatomy, resulting in more predictable outcomes and efficient treatment.

C) Clear Aligners in Pediatric Patients

With advancements in digital orthodontics, clear aligners are now being used in selected pediatric cases for minor tooth movement.

Digital treatment planning allows simulation of tooth movement and fabrication of a series of aligners using CAD/CAM and 3D printing. These aligners are aesthetically pleasing, comfortable, and improve oral hygiene maintenance, making them suitable for cooperative children.

Made from transparent thermoplastic materials such as polyurethane or polyethylene terephthalate glycol (PETG), these aligners are custom-fabricated using advanced 3D digital workflows.

**3.(5) Customized Tray in Fluoride Application**

Topical fluoride application often faces difficulties in maintaining an adequate fluoride concentration in the oral cavity for a prolonged duration because food intake and continuous salivary flow can gradually remove the fluoride from the tooth surface. To overcome the shortcomings of conventional fluoride products, 3D printing technology is being explored as an innovative alternative.

This technology enables the development of customized fluoride delivery systems, including thin films that can be precisely adapted to the tooth surface. These films act as protective coatings and provide a controlled, slow release of fluoride over time, thereby enhancing its long-term effectiveness and preventive action against dental caries.

**3.(6) Digital obturators**

Digital obturators can be fabricated using 3D printing technology to achieve precise adaptation to tissue defects within a significantly reduced fabrication time. The use of 3D printing allows customized obturators to be designed according to the patient's specific anatomical requirements, improving fit and comfort.

Polymethyl methacrylate (PMMA) is commonly used as a material for 3D-printed obturators because of its lightweight nature, good aesthetics, affordability, dimensional stability, and excellent biocompatibility.


## IV. Advantages of 3D Printing

3D printing offers numerous advantages in pediatric dentistry by improving the efficiency, accuracy, and comfort of dental treatment for children. The technology enables rapid fabrication of highly precise dental models, crowns, space maintainers, orthodontic appliances, surgical guides, and other customized restorations with better fit and adaptation.

Digital workflows reduce the need for conventional impression materials, thereby minimizing discomfort, gag reflex, and anxiety in pediatric patients. In addition, shorter chairside time and faster treatment procedures improve child cooperation and behaviour management during dental visits. 3D printing also supports a minimally invasive approach and enhances esthetics through customized restorations.

Digital storage of patient data allows easy reproduction of models without requiring physical storage space. Furthermore, printed models improve communication with children and parents by helping them better understand treatment procedures. Overall, the integration of 3D printing with CAD/CAM systems and intraoral scanners has significantly advanced modern pediatric dentistry by providing accurate, efficient, and patient-friendly treatment options.

CAD/CAM systems can be used in both chair side or in lab side

| FEATURE | Chairside CAD/CAM | Lab-Side CAD/CAM |
|---|---|---|
| **LOCATION** | Dental clinic | Dental laboratory |
| **TIME REQUIRED** | Same-day treatment | Multiple visits required |
| **COMPLEXITY** | Simple to moderate cases | Moderate to complex cases |
| **EQUIPMENT** | Compact milling units | Advanced milling units |
| **PATIENT CONVENIENCE** | Faster and fewer appointments | Longer treatment duration |

## V. Limitation and challenges

Although 3D printing has significantly advanced modern dentistry, several limitations still restrict its widespread application. One major concern is the limited resolution of some printers, which can affect the accuracy and fine details required for precise dental restorations and appliances. In addition, currently available printing materials may not completely match the strength, durability, and longevity of conventional dental materials. The speed of 3D printing can also be a disadvantage in emergency situations where immediate treatment is necessary.

Economic factors further limit its use, as 3D printers, specialized software, and materials require substantial financial investment. Moreover, although the actual printing process may be rapid, the pre-processing and post-processing procedures are often time consuming and technique-sensitive.

Other reported limitations include the need for skilled operators, restricted material options, increased manufacturing demands, and reduced accuracy with certain applications.

## VI. Future perspectives

The application of additive manufacturing in pediatric dentistry is still in its early stages, but its integration is expected to significantly improve both clinical practice and dental education. Continuous advancements in material science and printing technologies are likely to increase the accuracy, efficiency, and scope of dental applications, including complex orthodontic appliances and customized prosthetic restorations.

The future development of more biocompatible and environmentally sustainable materials may further provide safer and eco-friendly treatment options for pediatric patients. In addition, improvements in digital imaging systems and software are expected to simplify the design and manufacturing workflow, making 3D printing more accessible and cost-effective for dental clinics.

In dental education, 3D printing has the potential to transform student training by providing realistic and interactive models that closely simulate clinical conditions. These models can enhance practical learning experiences and also improve patient education and communication. As ongoing research continues to expand the possibilities of 3D printing, its role in pediatric dentistry is expected to grow further, contributing to a future of more precise, patient-centred, and technologically advanced dental care.

## VII. Conclusion

The integration of digital innovations in orthodontics and pediatric dental care has brought a significant transformation in modern clinical practice.

Technologies such as intraoral scanning, CAD/CAM systems, 3D printing, and artificial intelligence have enhanced diagnostic accuracy, improved treatment planning, and enabled the fabrication of highly customized appliances.

In pediatric patients, these advancements are particularly beneficial as they reduce chairside time, minimize discomfort, and improve cooperation through more child friendly approaches.

Digital workflows have also improved communication between clinicians, patients, and parents by providing better visualization and understanding of treatment procedures.

In interceptive orthodontics, early diagnosis and timely intervention have become more predictable and efficient with the use of digital tools. Despite challenges such as high initial costs, the need for technical expertise, and accessibility issues, the advantages of digital dentistry outweigh its limitations.

## References

[1]. Aktaş N, Ciftci V. Current applications of three-dimensional (3D) printing in pediatric dentistry: a literature review. *J Clin Pediatr Dent.* 2024;48(5):4-13. doi:10.22514/jocpd.2024.099.

[2]. Prajapati A, Prajapati A, Mody DR, Choudhary AB. Dentistry goes digital: A CADCAM way – a review article. *IOSR J Dent Med Sci.* 2014;13(8):53-59.

[3]. Zarean P, Zarean P, Sendi P, Neuhaus KW. Advances in the manufacturing process of space maintainers in pediatric dentistry: a systematic review from traditional methods to 3D-printing. *Appl Sci.* 2023;13(12):6998.

[4]. Marchesi G, Camurri Piloni A, Nicolin V, Turco G, Di Lenarda R. Chairside CAD/CAM materials: current trends of clinical uses. *Biology (Basel).* 2021;10(11):1170.

[5]. Beretta M, Federici Canova F, Zaffarano L, Gianolio A. DOP dentistry: digitally embracing orthodontics and paediatric dentistry. *Eur J Paediatr Dent.* 2022;23(4):295-297.

[6]. Basim M, Al-Khatib AR, Rajion ZA. Applications of 3D printing in pediatric dentistry: a literature review. *J Int Soc Prev Community Dent.* 2023;13(1):1-8.