*IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*
*e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 24, Issue 9 Ser. 5 (September. 2025), PP 81-86*
*www.iosrjournals.org*

# 'From Impression To Cementation': The Role Of Artificial Intelligence In Modern Crown Fabrication

Dr. Gopika S, Dr. Riswana Resvi, Dr. Samitha S, Dr. Aby Mathew T, Dr. Rene Kuriakose

*(Pg Resident, Department Of Prosthodontics And Crown And Bridge, Pushpagiri College Of Dental Sciences, Thiruvalla)*
*(Professor And Head, Department Of Prosthodontics And Crown And Bridge, Pushpagiri College Of Dental Sciences, Thiruvalla)*
*(Reader, Department Of Prosthodontics And Crown And Bridge, Pushpagiri College Of Dental Sciences, Thiruvalla)*

***Abstract***
*The incorporation of artificial intelligence (AI) in dental crown fabrication marks a groundbreaking advancement in contemporary dentistry, merging digital technologies with machine learning to produce restorations that are more precise, efficient, and customized than traditional methods[1]. Conventional crown design depends heavily on manual modelling, skilled technician input, and repeated modifications—practices that are often time-intensive, laborious, and prone to human error. In contrast, AI-driven crown fabrication utilizes high-resolution digital scanning, automated design algorithms, and advanced manufacturing processes to optimize every phase—from capturing the digital impression to manufacturing the final crown[1,2].*
*Recent progress in the field, including generative AI models and sophisticated 3D deep learning techniques, has enabled the production of crowns that closely replicate the natural morphology and biomechanical properties of teeth. Studies have shown that AI-generated crowns can deliver durability and functional performance comparable to healthy natural teeth, often outperforming traditional CAD/CAM methods in terms of morphological accuracy and fit[3,4]. Moreover, AI algorithms minimize the need for adjustments or remakes post-design and tackle challenges related to material optimization, sustainability, and faster turnaround times[6].*
*This comprehensive review focuses on the advancements, operational mechanisms, and clinical implications of AI in crown fabrication. It highlights the integration of AI within the larger digital transformation seen in prosthodontics and restorative dentistry, examining its current benefits, limitations, and future potential to revolutionize dental crown production[5,8].*

***Keywords:*** *Artificial intelligence (AI), Dental crown fabrication, 3D deep learning, CAD/CAM, Digital scanning, Automated design algorithms, Morphology, Biomechanics, Prosthodontics, Transformation, Clinical advantages, Material efficiency, Environmental impact.*

---

Date of Submission: 17-09-2025 Date of Acceptance: 27-09-2025

---

## I. Introduction

Artificial intelligence (AI) in dentistry refers to computer systems' capability to perform tasks that typically require human intellect, such as learning, reasoning, and problem-solving. AI has rapidly advanced in dental fields with significant impacts on diagnosis, prevention, and treatment planning[7].

Current AI applications in dental diagnostics include:

- Detection of dental caries on radiographs through AI image analysis.
- Evaluation of endodontic case complexity.
- Automated identification of cephalometric landmarks.
- Classification of different dental implant systems.

These applications are predominantly driven by machine learning—a branch of AI where computational models are trained on large datasets to recognize patterns and make predictions. By leveraging AI, dentists can achieve earlier detection of oral diseases, more accurate diagnoses, and personalized treatment plans. AI also supports virtual consultations, improves workflow efficiency, and enhances patient care[9].

The integration of AI in dentistry is transforming traditional practices by improving diagnostic accuracy, reducing errors, and optimizing clinical outcomes. This technology supplements dental professionals by analyzing

vast amounts of imaging and clinical data more rapidly and consistently than humanly possible, thus aiding in disease detection, treatment planning, and patient management[10].

## II. AI Driven Dental Crown Prosthesis

AI-driven dental crown prosthesis design utilizes advanced algorithms and machine learning to automate and personalize the creation of dental crowns, leading to improvements in fit, morphology, efficiency, and patient outcomes. High-resolution intraoral scans are processed by AI, which references large datasets to generate crowns that closely mimic the morphology and biomechanics of natural teeth and minimize human error or manual adjustments[2].

Researchers have demonstrated that AI-generated crowns can achieve lifespans and functional performance comparable to natural teeth, outperforming traditional CAD/CAM or technician-designed crowns in terms of 3D accuracy and biomechanical fit. Notably, generative AI models trained on hundreds of digital casts produced crowns with the lowest 3D discrepancy and most accurate occlusal contacts when compared to natural teeth, according to a 2023 study from the University of Hong Kong[3].

Compared to manual or conventional CAD/CAM design, the benefits of AI in crown production include faster turnaround (often hours instead of days), reduced material waste, lower production costs, decreased need for remakes, and a reduced dependence on technician experience. However, limitations persist, such as a lack of transparency in some commercial AI algorithms and smaller validation sample sizes in some studies. Clinical trials of AI-designed crowns are ongoing to confirm these advantages on a larger scale[3].

Current AI systems not only propose the geometry of the crowns but can also recommend the optimal material based on patient-specific factors, with fabrication typically performed via 3D printing or CNC [Computer Numerical Control] milling. This technology is rapidly evolving, with generative AI increasingly positioned as a foundation for the future of highly efficient, precise, and scalable dental prosthetics[4].

## III. Traditional Vs. AI-Assisted Crown Design: Key Differences

AI-assisted crown design has transformed how dental restorations are created, offering distinct advantages over traditional methods. The table below highlights the key differences[4]:

| Feature | Traditional Crown Design | AI-Assisted Crown Design |
|---|---|---|
| **Design Process** | Manual modeling by a technician | AI-driven automated modeling |
| **Accuracy** | Subject to human error | Precise AI-calculated measurements |
| **Time Required** | Several days to weeks | Often completed in hours |
| **Customization** | Limited to technician's skill | Highly personalized using AI data |
| **Material Optimization** | More waste due to trial & error | Efficient material usage |
| **Cost Efficiency** | Higher due to labor & time | Reduced costs with AI automation |

## IV. Dental Crown Prosthesis Designed By AI

The production of crown prostheses has been separated into traditional wax-up methods and digital approaches using CAD/CAM systems. Recently, there has been a widespread adoption of CAD/CAM methodologies, particularly in conjunction with the popularization of zirconia usage. Notably, these methods report high levels of accuracy and success rates [3]. In the CAD/CAM process, there have been efforts to enhance the speed and precision of prosthesis design through the application of AI [3,4].

AI-based operations minimize human intervention using automated calculations. Therefore, designing with AI significantly reduces the time spent on the design process, especially in cases with extensive restoration requirements.

AI for dental crown design has the potential to significantly increase production efficiency by saving time. Considering the performance demonstrated in aspects such as morphology, internal fit, and occlusion, there is a promising outlook for the future utilization of AI in dentistry[5].

The current leading AI software used in the formation of dental crown prostheses includes:

- **3 Shape Automate**: An AI-driven dental design service providing CAD/CAM crown designs in minutes, allowing dental professionals to approve only the designs they like. Features include automated case analysis and highly accurate, rapid single-crown proposals.
- **Exocad AI Design**: Offers AI-powered single crown design suggestions tailored to patient anatomy, adjacent teeth, and occlusion, completing proposals in about two minutes. Exocad has recently expanded its AI toolset for greater accuracy and automation in crown design workflows.
- **Dentbird CAD**: A fully web-based, AI-powered dental CAD system that allows automated digital crown design, streamlining workflows with no software installation required.

- **UP3D AI Crown Design**: Incorporates one-click AI-driven modeling within their CAD platforms, analyzing digital scans to generate optimized and personalized crown shapes with adjustable morphology.

These platforms typically use deep learning algorithms trained on thousands of previous restorations to automate the scanning, modeling, and proposal phases, greatly enhancing efficiency compared to traditional CAD and technician-led methods.

Recent studies indicate these AI-powered solutions achieve significantly higher time efficiency for crown design, often reducing working time to a quarter compared to novice CAD users. However, morphological accuracy—especially on complex surfaces—varies, and experienced technicians using traditional CAD may still outperform AI in very detailed morphology.

Additionally, other notable software integrating AI for dental crowns includes:

- **3Shape Dental System**: Advanced CAD/CAM suite using AI for predictive crown morphology and automated restoration proposals.
- **CareStack and Pearl**: While more focused on management and imaging, respectively, some ecosystems incorporate AI design tools alongside diagnostic features.

AI-generated crown designs generally involve the following steps:

- High-resolution intraoral scanning.
- AI-based analysis and automated digital modeling of the crown.
- Dentist review and final approval.
- Fabrication via 3D printing or CAD/CAM milling.

Current AI design software emphasizes efficiency, reproducibility, and reduced manual labour, but the highest accuracy with challenging morphologies may still require experienced technician oversight[4].

## V. What Is AI Dental Crown Design & How It Work ?

AI dental crown design is an advanced approach that leverages artificial intelligence to streamline and enhance the creation of dental crowns. By automating both the digital scanning and design phases, AI technology enables crowns to be produced more quickly and with greater accuracy[3].

These AI-powered systems analyze extensive databases of previous patient cases, allowing them to craft highly customized crown designs tailored to the unique oral anatomy of each patient. This reduces the risk of the errors often associated with manual techniques and provides patients with a more comfortable, precise fit.

Using high-resolution scans, AI algorithms generate a personalized digital model of the crown. This process not only accelerates production, but also improves the crown's durability, fit, and appearance[4]. The process starts with a thorough digital scan of the patient's teeth and mouth. These high-resolution images are processed by AI software, which references comprehensive databases of previous cases. The AI then automatically creates a crown design precisely tailored to the patient's unique dental anatomy[2].

Once the digital design is finalized and approved, the crown is fabricated using either 3D printing or CAD/CAM milling technologies. This streamlined workflow greatly reduces production time and lowers the potential for human error compared to manual techniques.

AI dental crown design allows dental professionals to increase efficiency, while patients benefit from crowns that look more natural, fit better, and can be delivered in less time.

**The Basics of AI-Powered Dental Crown Design**

AI-powered dental crown design represents a transformative advancement in dental restoration, integrating artificial intelligence with modern digital manufacturing techniques to produce crowns that are both highly accurate and tailored to each patient. The core steps in this approach are:

- **AI-Driven Scanning**: Sophisticated intraoral scanners capture extremely detailed images of the patient's teeth.
- **Machine Learning Analysis**: AI systems evaluate large datasets of past cases to recommend the most suitable crown shape and fit.
- **Automated Custom Design**: The software uses live data to automatically create a crown design specific to the patient's needs.
- **Digital Manufacturing**: Advanced 3D printers or CAD/CAM milling devices fabricate the AI-designed crown with minimal manual involvement.
- **AI-Based Quality Assurance**: The system checks and validates the final design, ensuring optimal fit and function before placement.

This innovative workflow greatly improves the accuracy and efficiency of crown production, minimizing the errors often seen with traditional manual methods and delivering superior patient outcomes[4].

## VI. Digital Scanning And 3d Modeling Process

AI-generated dental crown design employs cutting-edge technology to streamline the entire restoration process. It starts with a thorough digital scan of the patient's mouth using high-precision intraoral scanners, which capture accurate, high-definition 3D images of the teeth.

Here's how the process unfolds:

**Digital Impression:** A 3D scanner rapidly records the exact dimensions and contours of the patient's dental structures [figure 1]

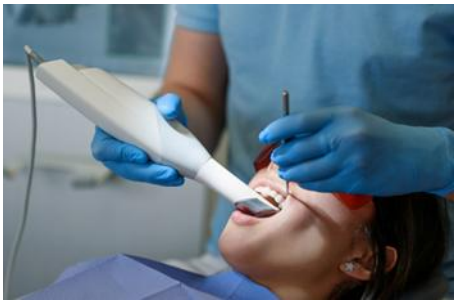

Figure 1

**AI Analysis:** The system's algorithms assess this data, referencing extensive databases of previous dental crown cases to inform the design.

**Automated Crown Design:** AI automatically creates a digital blueprint for a crown that is customized to the patient's anatomy, optimizing fit and function [figure 2].

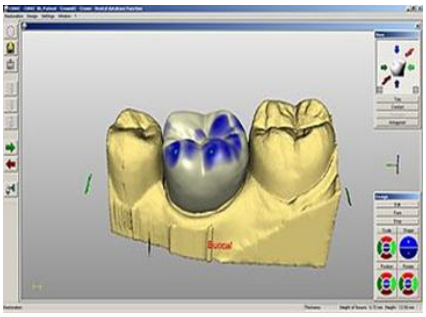

Figure 2

**Material Selection:** The AI recommends the most suitable dental material for the crown, tailored to the patient's specific clinical requirements.

**Final Adjustments & Approval:** The dentist reviews the AI-generated design, making any necessary modifications before giving final approval [figure3]

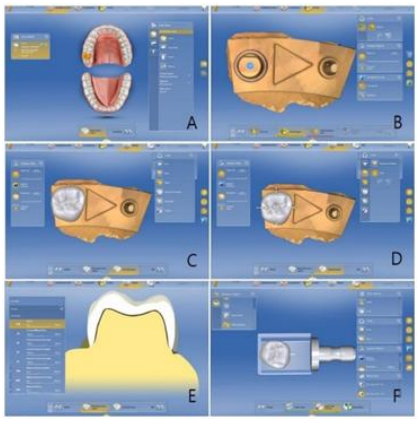


Figure 3

**Fabrication:** The approved crown design is then manufactured using advanced 3D printing or CAD/CAM milling methods [figure 4].

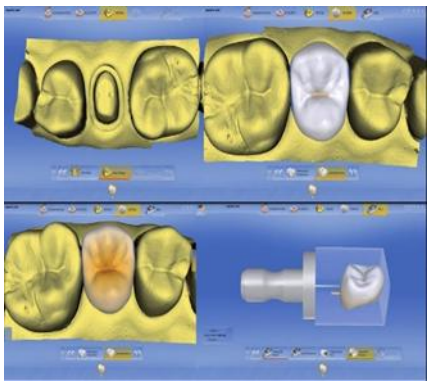

Figure 4

This digital workflow allows for faster production, higher precision, and a more predictable fit compared to conventional, manual techniques. The result is a crown that is both aesthetically pleasing and durable, providing improved comfort and efficiency for the patient and dental professional alike[4].

## VII. Benefits Of Digital Crown Design

By eliminating the need for physical impressions and manual modeling, AI enables the production of digital dental crowns with exceptional precision and speed. The incorporation of AI dental crown technology greatly accelerates the design and manufacturing process while enhancing accuracy. Whereas traditional crown design could take several days, AI often completes this in mere hours.

- **Improved Precision:** AI leverages vast datasets to ensure a highly accurate fit.
- **Minimized Human Error:** Automated modeling reduces mistakes common in manual design.
- **Time Savings:** AI generates crown designs within minutes instead of hours or days.
- **Consistent Predictability:** AI considers multiple data factors to deliver reliable outcomes.

As a result, digital dental crowns fit perfectly, lowering the need for adjustments and boosting long-term durability.

**Enhancing Patient Experience with AI**

AI technology also elevates the patient experience by offering faster treatment, better-fitting crowns, and a more comfortable process overall. Key benefits include:

- **Reduced Chair Time:** Fewer dental visits are needed for crown fittings due to quicker design and fabrication.
- **Better Aesthetics:** AI-driven designs produce natural-looking crowns with optimal color matching.
- **Increased Comfort:** Digital impressions replace traditional molds, eliminating discomfort during scanning.
- **Personalized Care:** AI customizes each crown to the patient's unique dental anatomy and requirements.

Through AI-generated dental crowns, dentists can deliver highly personalized, high-quality restorations that improve patient satisfaction and treatment outcomes[4].

## VIII. Conclusion

AI dental crown design technology offers significant advantages by improving clinical efficiency and enhancing patient satisfaction. This method enables faster production processes, customized designs, and improved success rates compared to traditional techniques. By automating the crown design process, AI reduces the likelihood of errors and shortens treatment timelines[7].

## References

[1]. Hyun-Jun Kong And Yu-Lee Kim. Application Of Artificial Intelligence In Dental Crown Prosthesis : A Scoping Review, BMC Oral Health (2024)24:937.
[2]. Briganti G ,Le Moine O Artificial Intelligence In Medicine : Today An Tomorrow .Front Med(Lausanne) 2020 ,7:27
[3]. Shan T, Tay FR, Gu L. Application Of Artificial Intelligence In Dentistry .J Dent Res . 2021,100:232 -44
[4]. Serif Baklaci ,What Is AI Dental Crown Design ? How Does It Work ? Craniotech March 2025
[5]. Feng Luo, Guang Hong And Qianbing Wan .Artificial Intelligence In Biomedical Applications Of Zirconia .Frontiers In Dental Medicine 19 August 2021.
[6]. Dinesh Rokaya ,Ahmad Al Jaghsi ,Rohan Jagtap And Viritpon Srimaneepong. Artificial Intelligence In Dentistry And Dental Biomaterials
[7]. Schwendicke F ,Samek W ,Krois J Artificial Intelligence In Dentistry : Chances And Challenges . J Dent Res.2020,99:769-74

[8]. Bindra S, Jain R .Artificial Intelligence In Medical Science ;A Review .Ir J Med Sci {2024} 193[3]:1419-29.Doi:10.1007/S11845-023-03570-9
[9]. Orhan K, Jagtap R. Introduction To Artificial Intelligence. Artificial Intelligence In Dentistry . Cham: Springer International Publishing (2023)
[10]. Agarwal P,Nikhade P.Artificial Intelligence In Dentistry :Past, Present And Future. Cureus(2022) 14(7):E27405 .Doi:10.7759/Cureus 27405