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CAD/CAM Fabricated Dentures: A Review

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ABSTRACT

In the field of Prosthodontics, traditional methods have long been regarded as the gold standard for fabricating oral and facial prostheses. However, the introduction of CAD/CAM systems in the late 1980s has revolutionized various aspects of dentistry, including the fabrication of inlays, crowns, fixed partial dentures, implant abutments/prostheses, and even complete dentures. The introduction of CAD/CAM technology has revolutionized precision and speed to an extent that was once unimaginable. In the last two decades, this technology has undergone remarkable progress and growth. This piece delves into the valuable advantages offered by CAD/CAM complete dentures and offers insights into the complex methods that drive their creation. This article aims to explore the potential advantages of CAD/CAM complete dentures and outline the techniques involved in their fabrication.

Keywords: CAD/CAM system, CAD/CAM dentures, polymethacrylate, digitalization, milled, machined, computerized

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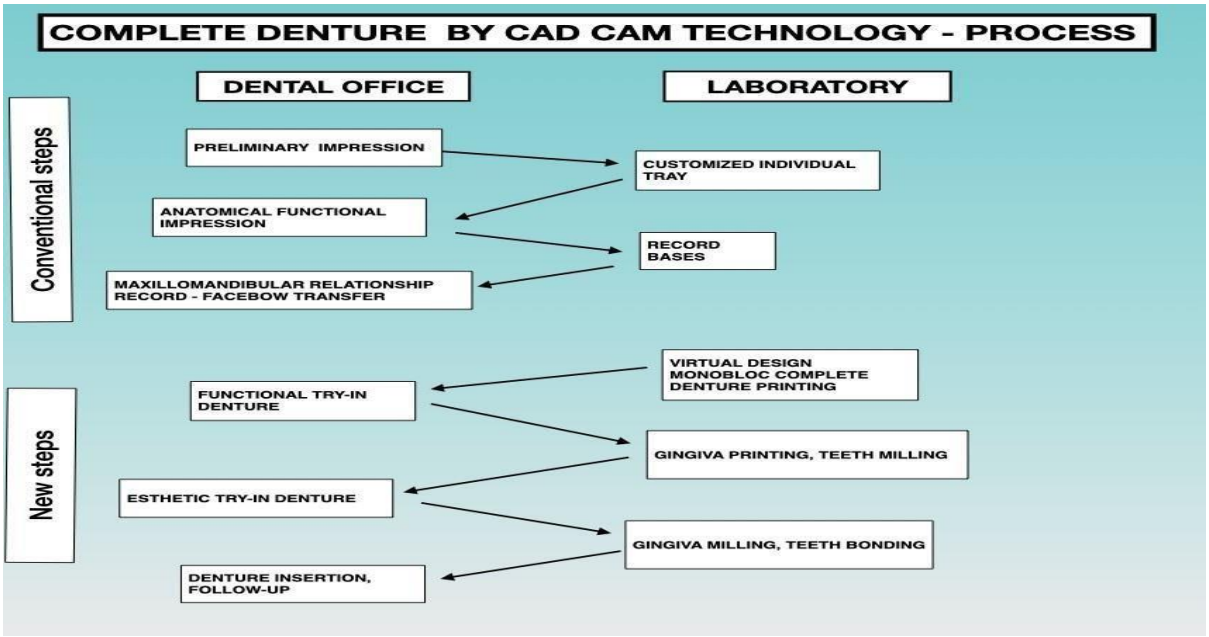
INTRODUCTION

Edentulism, or the absence of teeth, contributes to disability and impairment of function that significantly affect the general health and overall quality of life of an individual. For decades, conventional complete dentures have had favorable outcomes as a rehabilitation for edentulous patients. In the 21st century CAD-CAM has emerged as a new approach for planning and fabrication of complete dentures.[1]

It was Mormann & Brandestinni from Germanywho introduced CAD-CAM technology in 1989 into dentistry. Ever since, it has found widespread application in all branchesof Prosthodontics. These advanced technologies enable the precise design and fabrication of diverse restorations and dental prostheses, ensuring accuracy and precision in the process.[2,3]

CAD-CAM offers significant benefit for both operators and patients. In a single appointment lasting one to two hours, all the clinical data for complete dentures can be recorded, significantly reducing chair time and providing cost-effective and accuratelyfitting dentures.[4] Lost or broken dentures can be easily refabricated from saved digital data. Selection of the most appropriate denture system plays a crucial role, due to the differences in the manufacturers fabricating processes and protocols. Limited research for CAD-CAM fabricated dentures is available of whcich the main two systems studied are the AvaDent and Dentca systems[5,6]



Flow chart 1. Process of the Complete Denture by CAD/CAM Technology

Advantages of digital denture fabrication

I. Enhanced efficiency leads to fewer appointments required for patients to receive their removable prostheses.

II. Milling pre-polymerized acrylic resin causes shrinkage of the acrylic base, resulting in improved denture strength and fit.

III. Streamlined processes reduce the time needed for prosthesis manipulation during fitting.

IV. Reduced risk of microorganism colonisation on the surfaces of the denture decreases the likelihood of infection.

V. Significant advances in the standardization protocols for research on complete denture prostheses.

VI. Digital data storage enables easy replication and creation of trial dentures.

VII. Clinicians and technicians exhibit superior quality control, ensuring high-quality removable prostheses.[7]

Disadvantages of digital denture fabrication

I. Manufacturing challenges due to impression making, recording vertical relation, maintenance of lip support and MMR transfer.

II. Difficulty in accurately determining the mandibular occlusal plane.

III. Increased costs due to special materials and higher laboratory expenses.

IV. The absence of a denture trial prevents patients and dentists from evaluating the dentures before final fabrication.[7]

Systems For fabrication of CAD-CAM Dentures.

Systems for the Computer designed and Milled complete dentures seem to provide improved precision and efficiency. Some of the currently available systems in this field include:

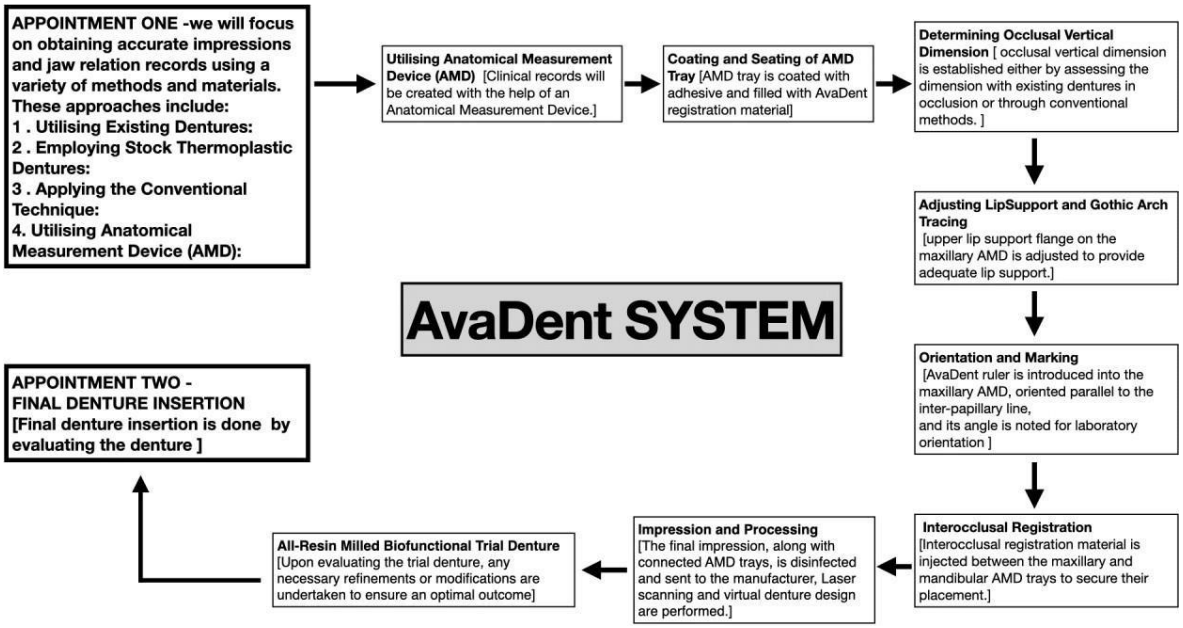
1. **AvaDent System**
2. **DENTCA System**
3. **Baltic Denture System**

4. **Wieland Digital Denture system**
5. **Ceramill full denture system**

These systems aim to improve the traditional denture fabrication process by reducing manual labor, enhancing accuracy and providing customization options. By incorporating CAD/CAM Technology, they streamline workflows shorten production times and enhance the overall quality of complete denture.

1. *AvaDent System*

AvaDent Digital dentures by Global dental science LLC in Scottsdale, AZ utilize advanced technology and substactive manufacturing methods to create high-quality complete dentures. They offer both milled & printed trial dentures for evaluation. The definitive complete dentures come in two forms: milled denture bases with bonded teeth or monolithic AvaDent XCL dentures. The XCL dentures have a single-unit construction, with the teeth and base milled together. There are two options within the XCL dentures: XCL-1 with monochromatic teeth, and XCL-2 with polychromatic teeth. The XCL-2 option provides a more realistic appearance, featuring translucent enamel like acrylic resin covering a dentin-coloured core.[8]



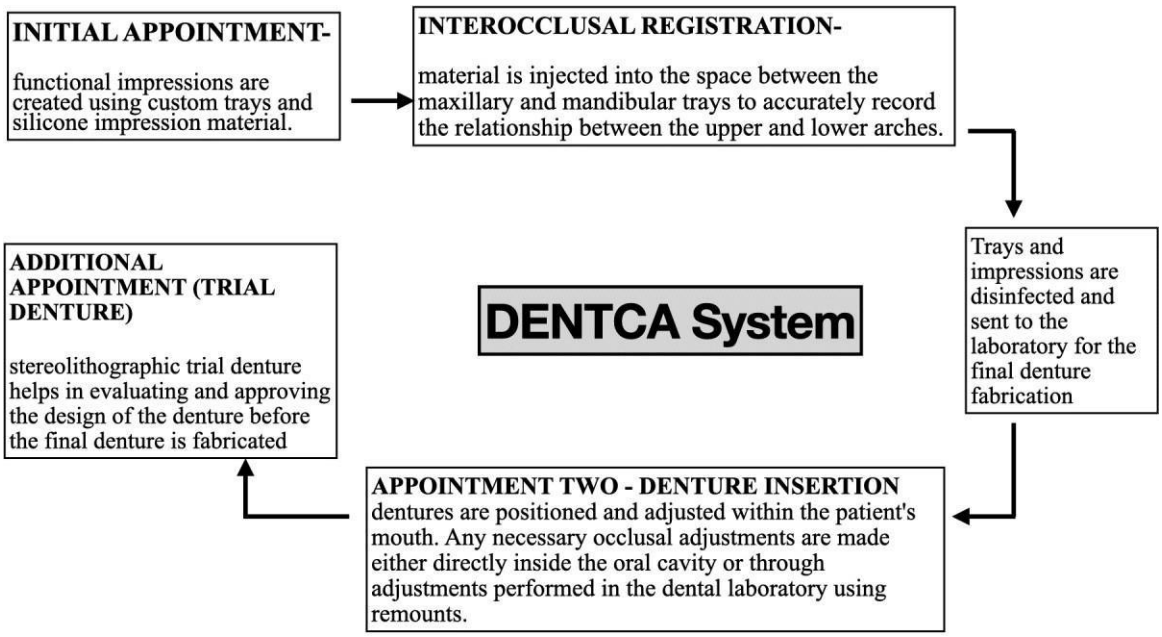
Trays of anatomic measuring device

Two-piece impression trays for impression and jaw relation

AMD at exact vertical dimension of occlusion and Centric Relation

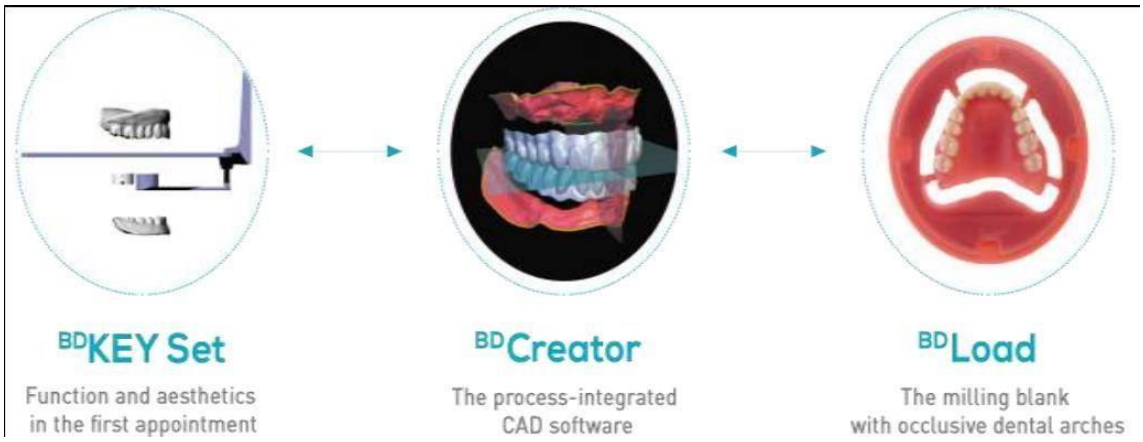
2. DENTCA System

DENTCA offers two-piece trays for both the maxillary (upper) and mandibular (lower) arches. These trays have detachable posterior segments, allowing for easy removal after taking final impressions. The anterior segments of these trays are used as record bases for recording the centric relation with gothic arch method. In addition to this, DENTCA provides the option of 3D printing or rapid prototyping (specifically, stereolithography) for creating trial bases. These trial bases serve as temporary structures for testing and evaluation. However, the definitive denture is still processed using conventional methods, ensuring high-quality results[9]



3. Baltic Denture System

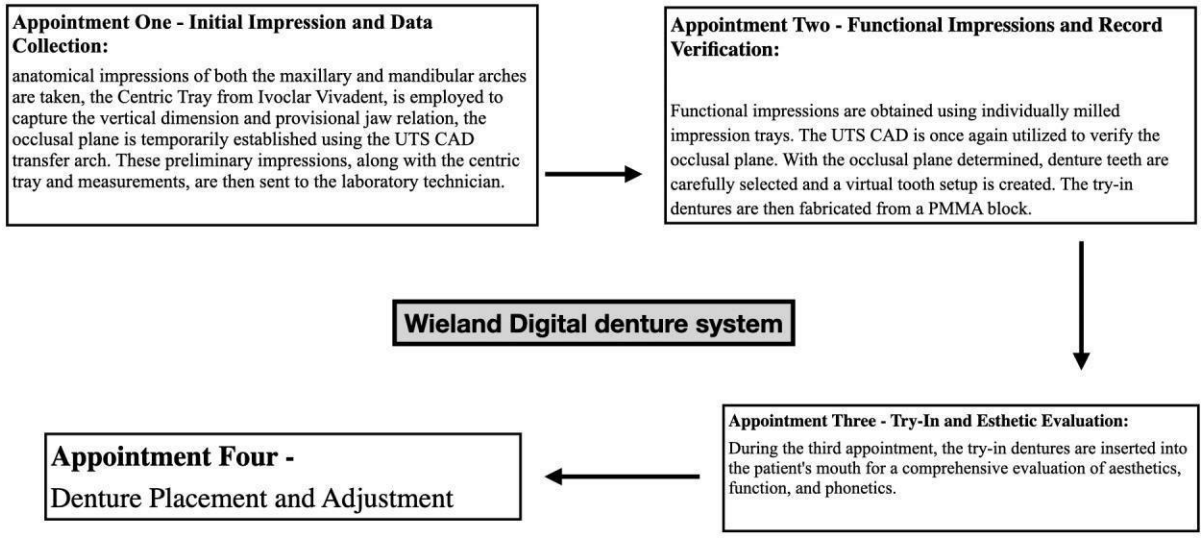
The Baltic Denture System offers the BDKEY Set components that enable the utilization of functional impression techniques. The initial set comprises adjustable record bases with teeth for both the upper and lower arches. These teeth come in three sizes; small medium and large; By incorporating teeth into the tray, the clinician can assess aesthetics, lip support, alignmemt of teeth and interocclusal space during evaluation. The BDKEY lock device provided in the kit facilitates the jaw relation record procedure. To mill the denture, this system uses a 5 axis computerized numerical control machine incorporating lingualized occlusion.[10]



Baltic denture system protocol

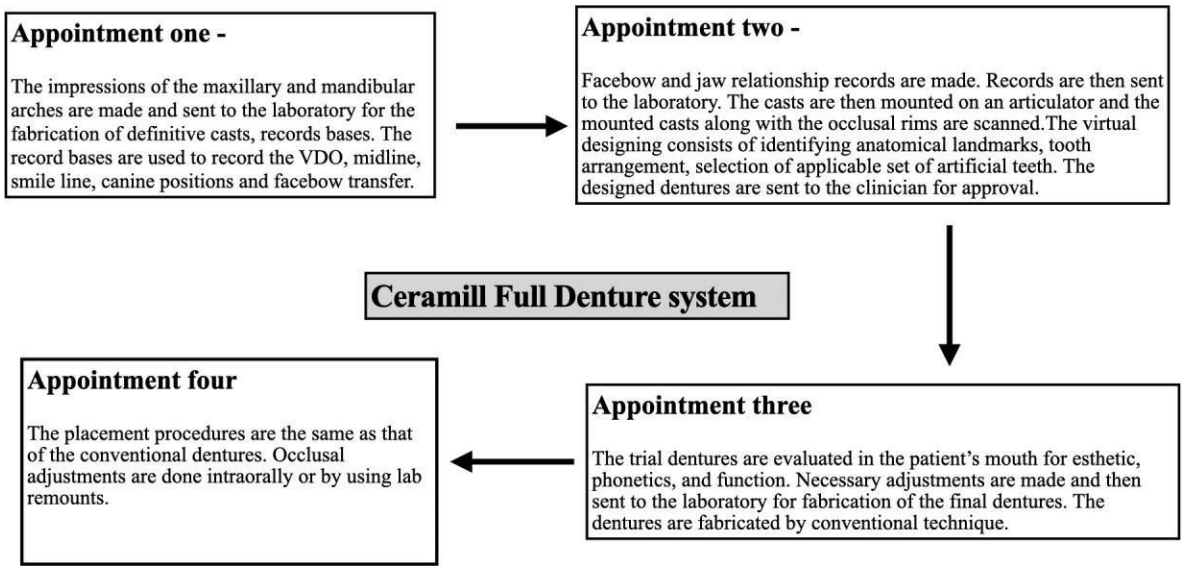
4. Wieland Digital Denture system

Wieland Digital Denture system utilizes a subtractive technique for denture base fabrication with a recess. The impressions and rims are scanned followed by the selection of teeth using CAD, from the software database and arranged virtually. After virtual occlusal adjustment, the machine, controlled by the operator, takes approximately 15 hours to fabricate two baseplates and two dentitions from acrylic composite plates. Since the milling machine has specific limitations, the teeth and the base are milled separately. Subsequently, the teeth are bonded in spaces provided allowing the dentist to clinically evaluate the phonetics and aesthetics. Finally, the teeth are permanently bonded to the prosthesis with an aligning jig[11,12]



5. Ceramill Full denture system

The dentures in this system are designed by the laboratory technician. The digital process commences within the laboratory environment, where a well-structured workflow comes into play. This workflow effectively aids in tasks such as tooth arrangement, the milling of wax trial bases, and the necessary adjustments to the denture teeth. These adjustments are carefully executed to facilitate the seamless insertion of the denture teeth into the tooth sockets present on the bases. It's worth noting that this integration is achieved without requiring further grinding, ensuring a precise and efficient production process.[13]



CONCLUSION

Recent advancements in dental technology have revolutionized the fabrication of removableprosthesis by utilizing CAD-CAM technology end-to-end through the entire process. This review article looked at the current CAD-CAM systems used to fabricate complete denture prostheses. The advantages are reduced chair-side time for the dentist & patient with superior aesthetics and function. CAD-CAM fabricated complete dentures represent a promising frontier in modern dentistry, offering a more efficient, precise, and patient-centered approach to denture prosthetics. With ongoing advancements and refinements in technology, CAD/CAM dentures could very likely be the prosthesis of choice shaping the future of dental care

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