*IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*
*e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 23, Issue 10 Ser. 1 (October. 2024), PP 37-41*
*www.iosrjournals.org*

# Recent Advances In Complete Dentures – A Narrative Review On Digital Complete Denture Clinical Workflows

Sneha N[1], Seyed Asharaf Ali[1], Suma Karthigeyan[1], Krishnaraj[1]
[1](*Department Of Prosthodontics, Government Dental College And Hospital – Cuddalore District, Chidambaram, India)*

***Abstract:***
*Complete dentures are one of the most challenging prosthetic treatments to be performed throughout history. It has undergone transformation during the last decade tremendously with introduction of digital dentistry. The efforts are being focused at reducing the duration and number of clinical appointments, making the process more predictable and repeatable. The milled pre-polymerized PMMA has superior physical and mechanical properties, better biological properties and polishability. It is necessary to understand the clinical workflow of the digital dentures to be able to apply them clinically, giving patients the best possible outcome.*
***Key Word:*** *Digital denture, digital workflow, complete denture, Recent advances.*

---

Date of Submission: 22-09-2024 Date of Acceptance: 02-10-2024

---

## I. Introduction

Complete dentures are prosthetic devices designed to replace all missing teeth in an edentulous arch, restoring both function and aesthetics for individuals who have lost their natural dentition. They play a critical role in prosthodontics, helping to improve quality of life by enhancing the ability to chew, speak, and smile confidently. It is defined as a fixed or removable dental prosthesis that replaces the entire dentition and associated structures of the maxillae or mandible[1]

The conventional process of fabricating complete dentures typically involves several stages, including clinical assessment, impression taking, jaw relation records, wax trial and final delivery of the prosthesis. A total of 5 to 7 clinical appointments and 5 laboratory steps are involved. The errors incorporated into the fabrication of complete dentures is cumulative in nature and precision and reproducibility is difficult to achieve as the work is done by hand and depends on skill and experience of the practitioner as well as the laboratory technician.

Recent advances in digital dentistry, such as computer-aided design and manufacturing (CAD/CAM) and 3D printing, have revolutionized the field, allowing for greater precision, faster turnaround times, and improved patient outcomes, enhanced the durability and predictability of complete dentures.

In this view, it is necessary to remain updated with the current advances in the field of complete dentures to provide the best possible patient outcome.

## II. Recent Developments In Complete Denture Impressions

Introduction of digital dentistry into complete dentures begin with data acquisition. There are two methods to digitise data – direct and indirect.

**Direct method -** involves direct intraoral scanning of the edentulous arch using the intraoral scanners. Intraoral scanning shows some advantages compared with conventional impressions, such as improvement of patients' comfort (no gag reflexes, reduced chairside time, fewer appointments) and facilitation of laboratory procedures (cast preparation, handling and shipping) without the need of physical casts. Limitations of direct intraoral scanning for edentulous patient includes

- The mobile soft tissue,
- The smooth mucosal surface texture covered by saliva,
- The formation of a saliva lake,
- The movements of the tongue and cheeks,
- The management of frenula, and
- The lack of stable references

The basic principles of complete denture impressions where forces can be applied to the borders and supporting areas cannot be done using an intraoral scanning device. Though methods have been attempted to

record the limits of the mucosa by using cheek retractors and pulling the cheeks to the functional limit, recording of the muscular movements are not yet possible using the direct scanning method. Thus the impression obtained is similar to a "mucostatic" impression where all the limitation of the technique apply.

**Indirect method** – conventional border molding and final impression is carried out and this impression or the master cast is then scanned to obtain a digital model for fabrication of the denture. This is the current norm for most commercial digital denture systems.

**Heat mouldable impression trays**

These are thermoplastic trays which, when immersed in hot water bath, can be moulded to fit the patient's mouth more closely, thus producing a better impression. Accudent XD is one such tray supplied by Ivoclar, to be used in conjunction with their digital denture system.

## III. Recent Developments In Complete Denture Jaw Relations

Conventional jaw relation involves the construction of wax occlusal rims which are adjusted to the patient's esthetics, phonetics and vertical dimensions before the relationship is recorded tentatively, followed by tracing to obtain definitive jaw relationship. Current digital systems involve 2 systems for capturing the jaw relations – centric tray, intraoral tracing.

**Centric tray**

Provided by Ivoclar for use in their BPS system and digital denture system. It has provision for impressions of upper and lower arches to be recorded at the same time. Gives tentative jaw relation record only. There is little scope for alteration of the vertical dimension. Esthetics and phonetic evaluation is not possible.

**Intraoral tracing apparatus**

Intraoral tracing apparatus is incorporated in the impression tray (Dentca systems) or attached as a gnathometer (Ivoclar denture systems). Vertical dimension set according to measurements between two tattoo marks (Willis Gauge/Niswonger's method). Helps in establishing definitive jaw relation according to gothic arch tracing obtained.

Because the lack of usage of occlusal rims, anatomical measurements are used for selection and position of teeth. Use of papillameter has been advocated for measuring the incisocervical length of the anterior teeth. Interaral distance can be used to determine the width of the upper anterior.

Efforts are being made towards a fully digital approach to evaluating the mandibular position in relation to the maxilla, utilizing the acquired data of the various imaging techniques. The idea is to reproduce the function of the traditional articulator in digitally simulated movements through the development of mathematical models. Virtual articulators and jaw motion analysers have been used in conjunction with data from CBCT with potential to accurately simulate the mandibular movements and condyle trajectories. Despite the attempts to merge intraoral scans with face scans and integrating virtual face-bows and articulators, digital denture technology is still behind as regards the registration of maxillomandibular relationships. It seems that the construction of baseplates with wax rims and recording of edentulous jaw relationships are, at the moment, unavoidable for the construction of truly customised complete dentures.

## IV. Recent Developments In Complete Denture Trial

Single appointment CAD/CAM dentures have the drawback of lack of try in stage. To overcome this, printed and monolithic milled trial dentures are being used. These trial dentures may be fabricated in one of the following ways

- Denture base and teeth printed separately and then joined together,
- Denture base milled, denture teeth waxed onto the denture base
- Monolithic trial denture milled from single block

There is still room for improvements, since only a few of the existing artificial teeth series have been digitized and, therefore, are compatible with the CAD software. The software might also allow changes to the shape of each tooth separately for detailed characterization. Future scope in this arena may involve use of Artificial intelligence (AI) and Augmented Reality(AR) to verify the esthetics for the patient before fabrication of denture.

## V. Manufacturing Methods In Digital Denture Systems

**Additive manufacturing**

The additive method (also called rapid prototyping) was invented in 1981 and commonly called "3D printing". It involves fabricating 3D object in a layer-by-layer fashion based on the relevant CAD file. The base

and teeth are separately oriented in printer specific software and oriented in a way to control printing time, printing support locations, and printing accuracy. These are then printed separately. The printed teeth and base must be cleaned of any unpolymerized resin by placing in isopropyl alcohol. Subsequently, the teeth are bonded to the denture bases with liquid (unpolymerized resin) material from the printer tank and, finally, light-cured for complete polymerization. Some printed denture workflows only print the denture base and use conventional denture teeth.

The two primary methods used to fabricate 3D printed digital dentures are digital light processing and stereolithography which are commonly referred to as vat-polymerization technologies

Currently available commercial systems that use additive manufacturing are the Dentca system and the Densply sirona Lucitone resin system.

Additive manufacturing is attractive due to the lesser processing time, cheaper cost of the equipment, ability to manufacture multiple dentures at the same time and reduced wastage as a result of the processing. However, the additively manufactured dentures are yet to be researched in a long-term clinical perspective and currently used primarily for fabrication of trial dentures and interim dental prosthesis.

**Subtractive manufacturing**

Subtractive manufacturing involves fabrication of the denture from pre-polymerised PMMA discs or "pucks". These discs are manufactured under high temperature and pressure, therefore highly compacted and imparts better mechanical properties than conventionally processed heat polymerised PMMA. The dentures may be manufactured in one of the following ways:

- Denture base milled separately, teeth milled separately – bonded together (Eg: Ivobase(Ivoclar))
- Denture base milled prefabricated denture teeth bonded into the recess (Eg – AvaDent)
- Denture base and denture teeth milled as a single unit – monolithic (Eg – Ivotion (ivoclar), AvaDent XCL monolithic dentures)

**Advantages of milled PMMA**

- A higher flexural strength, fracture toughness, and modulus of elasticity, allowing in the indicated case the fabrication of a thinner denture base
- higher surface hardness
- Better surface properties (smoother surface texture, more hydrophilic, better wettability) - may lead to a better color stability and a decreased susceptibility to surface staining
- A higher overall accuracy of the denture base for the milled, over the 3D printed, and over the conventionally fabricated denture base
- A better denture retention mainly due to the absence of polymerization shrinkage
- A reduced affinity for adhesion of Candida albicans on a CAD-CAM denture base than to a conventional base - decrease of the incidence of denture stomatitis

**Comparison of additive and subtractive manufacturing in CD**

Both CAM technologies offer clinically acceptable results faster than the traditional process. The additive manufacturing technique is more recent and has the advantage that a 3D printer is more affordable than a milling machine. Accuracy for both techniques seem to be acceptable, however 3D printing might present a higher variance, such as the print orientation affecting the accuracy needs to be studied. Although in laboratory studies the wear resistance of the 3D-printed artificial teeth seem to be at least adequate for denture use, long duration randomized clinical trials are necessary for in depth evaluation of this aspect. Regarding other mechanical properties, CDs produced with the subtractive method have been found to be superior in toughness and surface roughness than the 3D-printed ones. Additionally, the CDs produced with the subtractive method have been found to have better color stability than the ones produced with the additive technique. Though overall properties are better with milled dentures than printed dentures, the effect of these differences in a clinical scenario needs to be studied further. If the properties are found to be within clinically acceptable limits, the additively manufactured dentures might even replace the subtractive manufacturing entirely.

## VI. Clinical Workflow

The clinical workflow for a digital complete denture may comprise of three or four appointments depending on the situation. The workflow also depends on the digital denture system being used. Broadly the workflows may be divided as – Reference denture method, predominantly digital, predominantly analog wrokflows.

**The first appointment – Data acquisition**

First clinical appointment involves acquiring data necessary for the digital denture fabrication. This information includes impressions, jaw relationships and may be done in one or two steps. If the patient has a pre-existing denture, it can be used to make a border molded final impression. In the absence of older dentures, heat molded impression trays may be used in conjunction with hydrocolloid/PVS impression materials or stock tray may be used to make the preliminary impressions following which a custom tray is fabricated for further border molding and final impressions. This step is usually combined with Jaw relationships where the record bases act as the tray for final impressions. Incorporating intraoral tracer during the jaw relationship deems the relationships more accurate due to the established gothic arch tracing performed. These analog records made are then digitized using a laboratory scanner to proceed with the digital denture design process.

Alternatively, intraoral scanner can be used for obtaining digital impressions. CBCT, in conjunction with intraoral and facial scans/photographs may be used to obtain a truly virtual patient, by using the reference points on the patient's face to orient the patient to the virtual articulator. Additionally, jaw movements may be recorded using jaw motion analyzer. This constitutes a predominantly digital workflow.

**The second appointment – trial appointment**

The digitally designed denture has to be tried in the patient mouth for esthetics, lip support, visibility, phonetics, vertical dimension, jaw relationships, occlusion, fit of the denture base, retention, stability and occlusal plane. Any discrepancies in this appointment should be communicated to the lab. If any corrections are needed in the intaglio surface of the trial denture, the modifications should be made and corrective wash impression should be made. The trial appointment may need to be repeated for verification.

One disadvantage with the monolithic milled/printed trial dentures is the inability to alter the teeth during the trial appointment. This imparts a sense of lack of control, especially in patients and dentists who have experienced the comfort of achieving the same in conventional complete dentures. A method of creating a recess in the denture base larger than the tooth and sealing the teeth using wax has been employed which gives room for small alterations in tooth positioning.

**The third appointment – denture delivery**

The denture is processed by one of the methods mentioned – additive or subtractive PMMA. Alternatively, it can be milled wax denture bases onto which teeth are sealed and processed conventionally. The dentures are then finished and polished before delivery.

During insertion, pressure indicating paste (FitChecker, GC) used to check for pressure spots. Occlusion is verified. Often, clinical remounting may be essential to obtain proper occlusal balance.

**Advantages of CAD/CAM Dentures**

- The prepolymerized acrylic resin used to fabricate milled CAD/CAM complete dentures is dimensionally stable and provides a superior fit of the denture bases whereas the resin of conventional processed bases undergoes polymerization shrinkage
- The prepolymerized acrylic resin has improved physical properties allowing for designing a thinner base overlying the palate.
- improved physical properties of the milled base material - more hydrophiliv (wettable), contains less residual monomer, has a smoother surface, provides better resistance to surface staining, and exhibits a higher modulus of elasticity, flexural strength, and fracture toughness.
- In addition to containing less residual monomer, the milled prepolymerized acrylic resin is denser than heat-activated conventional denture base resins
- reduction in the number of patient visits, a major advantage and convenience for those older patients
- The reduced clinical chair time required for the fabrication of complete dentures makes complete denture treatment more cost-effective by decreasing the clinician's overhead
- the repository of digital data (images, tooth arrangements, etc.) can be used for future fabrication of a replacement denture or a surgical/radiographic template

**Limitations of CAD/CAM Dentures**

- Clinical remounting required to achieve balancing contacts
- Learning curve - cause disappointment and less than ideal results during initial dentures
- If the laboratory is not in close proximity to the dental office or is located out of state, the clinician will need to use scannable, dimensionally stable, temperature resistant impression materials.
- communication with the dental laboratory can be more challenging and may be required multiple efforts to resolve design-related issues

- the cost of materials and laboratory fees are greater than that of conventional fabrications processes in some parts of the world.
- The impact of CAD/CAM on the environment should not be neglected, the milling procedures produce resin particles, which contribute to the plastic pollution of the environment.

## VII. Conclusion

The transition to digital dentistry in the field of complete dentures has been slow but steady. With numerous studies being conducted in CAD/CAM dentures, it is possible that in near future it will become the standard of care, However, the basic prosthodontic principles and its understanding cannot be thrown aside, and the new technology should be embraced with these principles in mind

## References

[1]. Glossary Of Prosthodontic Terms 9 (GPT9).
[2]. Baba NZ, Goodacre BJ, Goodacre CJ, Et Al. CAD/CAM Complete Denture Systems And Physical Properties: A Review Of The Literature. Journal Of Prosthodontics 2021; 30: 113–124.
[3]. Villias A, Karkazis H, Yannikakis S, Et Al. Current Status Of Digital Complete Dentures Technology. Prosthesis 2021; 3: 229–244.
[4]. Marinello CP, Brugger R. Digital Removable Complete Denture—An Overview. Curr Oral Health Rep 2021; 8: 117–131.
[5]. Maragliano-Muniz P, Kukucka ED. Incorporating Digital Dentures Into Clinical Practice: Flexible Workflows And Improved Clinical Outcomes. Journal Of Prosthodontics 2021; 30: 125–132.
[6]. Goodacre BJ, Goodacre CJ. Additive Manufacturing For Complete Denture Fabrication: A Narrative Review. Journal Of Prosthodontics 2022; 31: 47–51.Colhoun HM, Betteridge DJ, Durrington PN, Et Al. Primary Prevention Of Cardiovascular Disease With Atorvastatin In Type 2 Diabetes In The Collaborative Atorvastatin Diabetes Study (CARDS): Multi Centrer Trial. The Lancet. 2004; 364(9435) :685–696.