FABRICATION OF COMPLETE DENTURES USING CAD/CAM TECHNOLOGY

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ABSTRACT:
Computer aided design-Computer aided manufacturing (CAD-CAM) is considered to be an upcoming, successful and a good herald for future dentistry. CAD software relates the geometry of the object while the CAM software directs the fabrication process. Conventional methods of fabricating complete denture prosthesis require several appointments to record the maxillomandibular relationships and to evaluate the esthetics. The information for the development of a CAD/CAM cast or restoration can be obtained either extraorally or intraorally. The development of computer generated dentures is indeed creating a revolution in the field of dentistry. The difference between CAD/CAM generated and conventionally made complete dentures lies in the fact that laboratory work is simplified and as few as two appointments are needed. The major disadvantage with the conventional dentures is the 'polymerization shrinkage' which can be overcome by the CAD/CAM technology resulting in increased patient satisfaction. This article aims to bring about the methodology,advantages and disadvantages of fabricating a complete denture using CAD/CAM technology.

INTRODUCTION:

The CAD/CAM technology was introduced by Duret in 1971 in restorative dentistry and in 1983, the first dental CAD/CAM restoration was manufactured(1,2). Since1971, Duret started fabrication of crowns in which occlusal surface was made wherein an optical impression of the abutment tooth was made in the mouth, and designing was planned using functional movements. Duret then milled a crown with a milling machine that was coordinated numerically. The CEREC 1 system was the first system to be introduced for dental purpose that made a hallmark in the mid 1980's which was developed by Siemens Corporation. The ceramic reconstruction or CEREC system is an acronym for "Chair side economical restoration of esthetic ceramic" and was first introduced in 1987(3). Now-a-days, CAD-CAM has gained popularity even for the fabrication of complete dentures and removable partial denture frameworks(4).
Initially, the use of CAD-CAM focussed on the fabrication of fixed restorations such as inlays, onlays, crowns and bridges. The inability to scan and read the soft tissue and the interocclusal relationship was a drawback in fabrication of complete and partial dentures. In the recent years, advancements in the CAD-CAM technology has made fabrication of complete and partial removable dentures possible. The fabrication of complete denture using CAD-CAM involves impression making with rubber-based impression material using a specially designed double impression tray(5). These trays are adjusted at a certain vertical dimension in the patient's mouth and are then retrieved and transferred to the 3D laser scanning system. A 3D digital model is obtained after scanning the impressions. This data can be used for arrangement of teeth after shade selection. The 3D image is used for development of a 3D model of the denture to be fabricated and then it is milled using a milling unit(5,6).

FABRICATION OF COMPLETE DENTURE PROSTHESIS BY CAD/CAM TECHNOLOGY:

Currently, two techniques are being used for the actual fabrication of CAD/CAMdentures. One process (the AvaDent system) uses the subtractive technique of milling a denture base from a prepolymerized "puck" of denture base resin and the other process (the Dentca system) uses an additive technique whereby rapid prototyping (stereolithography) is used to form a trial denture.
The following are the steps to fabricate a complete denture by CAD/CAM technology:

1.A definitive impression is made with the impression materials and thermoplastic moldabletrays which are available in different sizes(AvaDent). Two part heavy-consistency polyvinylsiloxane(PVS) is mixed and pressed into the existing denture to create a PVS cast.

2.The residual ridge is measured and the appropriate thermoplastic tray is selected.The tray is placed in a hotwater bath (77 degree celsius) and molded to the cast.

3.The tray is evaluated intraorally to ensure it covers all the appropriate anatomic areas and the borders are adjusted as needed. As with any conventional edentulous impression method, the tissue is dried with a gauze. First,the mold is bordered with heavy-body material and the definitive impression is made with a regular-set light-body PVS material.

4.The correct size anatomic measuring device(AMD)(AvaDent)is chosen by using the caliper to measure the widestpart of the residual ridge. If the residual ridge is between sizes, the smaller AMD is used. With the existing dentures in the mouth, the occlusal vertical dimension(OVD)is assessed and rest position with a preferred assessment method(7). These dimensions are verified and necessary changes are made. Once established,dots are placed on the patient's facial features and the OVD with a caliper is recorded.

5.The AMD maxillary tray is recorded with the specified adhesive (Expressfast set polyvinylsiloxane PVS maxillo mandibular registration paste) material on to the tray and placed intraorally to stabilize the AMD on the residual ridge before taking the records. The AMD mandibular tray is coated with adhesive,the PVS maxillomandibular relationship recordmaterial is loaded on to the tray,and the tray is placed in the mouth. The mandibular AMD is extended as far posteriorly as possible and placed horizontally.

6.Both AMDs are placed in to the mouth and the Ava Dentruler is attached. The ruler is aligned parallel to the interpupillary line and the angle is recorded that will be used to correlate the completed AMD to the virtual mounting with software algorithms. A central bearing tracing device resting on the mandibular tray is used to adjust the OVD by turning the fitting on the side of the AMD to raise and lower the central bearing pin. Then the OVDis confirmed. To confirm the centric relation with agothicarch tracing,the tip of the bearing pin is coated with a marking agent,then the mandibular tray is coated with occlusal spray,or rubbed with occlusal paper. The patient's mandible is guided back and lateral,anterior,and posterior aspects are traced on the mandibular tray with the bearingpin. The patient is directed to"keep jaws together,""to slide lower jaw as far forward as possible,"and "as far back as possible,"and"as far left and right as possible." The gothic arch is traced accordingly.

7.The mandibular tray is removed and divot is drilled into the tray at the tip of the arrow. The tray is replaced intraorally, then the tip of the pin is placed into the divot, and the AMD is stabilized by liberally injecting maxillomandibular relationship record material into the area between the maxillary and mandibular AMD tray. Any record material is removed from the maxillary AMD that might interfere with the lip. The lip support is adjusted to the desired lip fullness by turning the fitting on the anterior of the lip support.

8.As a guide for selecting the appropriate denture tooth mold,the esthetic transparent guide is overlaid on to the existing denture. One of three overlay esthetic transparent guides is chosen which represent different tooth sizes. Once the proper transparent guide is chosen, the desired gingival height is determined and marked on the prescription. The midline and incisal edge for the anterior teeth on the lip support is marked. Composite resin(TetricEvoFlow) is added on to the transparent guide and adhered to the lip support. With the AMD in the mouth, the esthetics and OVD are verified.

9.Both the completed impressions and the final AMD are sent to the laboratory for fabrication of the dentures.

10.The digital preview virtual setup is examined and sent by the laboratory,and the design of the denture is modified if needed.

11.Once processed, the dentures are returned to the dentist for delivering it to the patient.

ADVANTAGES OF FABRICATION BY CAD/CAM TECHNOLOGY:

Application of new materials

Advancement and development in the material science has constantly motivated to develop newer manipulation techniques also. Initially,Introduction of high-strength ceramics was brought into consideration for processing FPD frameworks but it was difficult to process them using conventional dental laboratory technologies. Such high strength dental ceramics could be used with the CAD/CAM technology for processing fixed prosthesis (8,9). Recently,this has even been extended to complete denture fabrication whoch has reduced the chair time both for the operator as well as the patient and increased patient compliance.

Reduced labor

The application of CAD/CAM technology reduces the labour cost and the chair side time. The total processing time is much shorter than that of conventional methodology which is arduous for the operator and the patient due to increased appointments. With regard to particular esthetic requirements, completed dentures completed merely by a conventional and simple method had many flaws. The esthetic requirements can be more accurately met when compared to the conventional techniques (8,9).

Cost effectiveness

In case of FPDs, production of all-ceramic FPDs using a zirconia framework fabricated by a CAD/CAM process could provide even more financial benefits to dental laboratories because they can invest in small measuring machines and not in large expensive facilities; thus they could concentrate on conventional porcelain processing(8,9).

Quality control

In case of FPDs, clinical and in vitro studies using finite element and fractographic analyses show that the primary causes of failure reported for all-ceramic FPDs differed from those reported for the metal-ceramic FPDs. Fractures of complete dentures tended to occur in the especially in the mandible due to human error and other variable reasons. Therefore, fabrication of complete dentures by CAD CAM technology is indeed advantageous as it guarantees more accuracy and reduces the appointments. Quality is also improved when compared to conventional dentures. CAD better guarantees the durability and reduces the risk of fracture (10,11).

DISADVANTAGES:

The artificial teeth and denture base are equipped with different colors and properties. The artificial teeth need high abrasion resistance and an aesthetic appearance. It is difficult to cut the artificial teeth from a single property block. Thus, only the denture base is fabricated by cutting then commercially available artificial teeth are adhered to the denture base. Special adhesives with higher adhesive properties are being developed (12).

Another disadvantage is the missed trial insertion appointment. This step allows making judgments of esthetics and pronunciation and verification of jaw relationship records, including orientation of the occlusal plane, vertical dimension, tongue space, tooth positioning, palatal seal and soft tissue support for proper external form. This is why a third appointment in the advanced fabrication technique could be added(13).

AvaDent Advanced Try-In (ATI) uses the final base with teeth waxed on. This technique provides teeth adjustment, relining, VDO modification, full adjustment capabilities. The only drawback is the additive cost. Dentca Try-In is a Stereo Lithographic Analog (SLA) of the digitally designed denture that fits like the final denture with a fine final contours and the possibility of checking the midline, the incisal plane and the lip support. The setback in this case is the frosty clear appearance of teeth that cause difficulties to evaluate shade and esthetics, and added to it the fact that we cannot move the teeth(14).

CONCLUSION:

The actual process of computer-aided designing has included laser scanning(15)of definitive impressions or previous dentures(16), as well as the use of cone beam computerized tomography (CBCT) of modified existing dentures(17). The computer-aided manufacturing process has utilized laser lithography(15), computer numerical control (CNC) milling techniques(16), refined versions of the rapid prototyping technique(18,19) and state-of-the-art CNC techniques that used five-axis milling(17).

Utilization of a classification system such as the Prosthodontic Diagnostic Index developed by the American College of Prosthodontists(20) might be beneficial in early and appropriate determination of technique for different clinical situations. Though every system has its own pros and cons so does the fabrication of complete dentures by CAD CAM technology but it is indeed a better method than the conventional one.

However, the essence of success of fabricating a complete denture through CAD CAM technology depends on the skill and knowledge of materials, anatomy, occlusion, function, making excellent impressions, registering the interocclusal record with a special device and determining the proper esthetic parameters.

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