

# CAD/CAM Complete Dentures for Atrophic Alveolar Ridges: Workflow Combining Conventional and Novel Techniques

Carlos Jurado<sup>1</sup>, Mohammed E. Sayed<sup>2</sup>, Zinaida Kaleinikova<sup>1</sup>, Chin-Chuan Fu<sup>3</sup>, Alfredo Hernandez<sup>1</sup>, Jose Tinoco-Villalobos<sup>4</sup>, Saad Alresayes<sup>5</sup>, and Akimasa Tsujimoto<sup>6</sup>

<sup>1</sup>A T Still University - Arizona Campus

<sup>2</sup>Jazan University

<sup>3</sup>The University of Alabama at Birmingham School of Dentistry

<sup>4</sup>Universidad Autonoma de Queretaro

<sup>5</sup>King Saud University College of Dentistry

<sup>6</sup>Nihon University School of Dentistry Graduate School of Dentistry

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## Abstract

CAD/CAM complete dentures have shown to improve the fit and material strength than conventionally fabricated dentures, however there are no clinical protocols described for extreme residual ridge resorption. This report describes a combined workflow of conventional and novel techniques for CAD/CAM complete dentures fabrication for atrophic alveolar ridges.

## Key Clinical Message

Extreme residual ridge resorption is a challenging clinical situation for the fabrication of complete dental prostheses and this clinical report demonstrates a CAD/CAM workflow solving this complicated situation.

## CAD/CAM Complete Dentures for Atrophic Alveolar Ridges: Workflow Combining Conventional and Novel Techniques

## Introduction

It has been stated that edentulism is the final result of a multifactorial process comprising biologic and patient-related factors.<sup>1,2</sup> Complete edentulism has been decreased in developed countries but it still remains as a significant problem for elderly population that could vary from 15% to 54% of the senior population.<sup>3</sup> Removable complete dentures are the least invasive and most affordable option for the prosthodontic rehabilitation of edentulous patients.<sup>4</sup> Treatment of edentulous patients with full complete dentures demands many technical steps, in which making accurate impressions is considered one of the essential steps for complete dentures fabrication.<sup>5,6</sup> Well-fitting removable complete dentures reduce the occurrence of traumatic ulcers and show higher prostheses wearing comfort.<sup>7</sup> Denture retention is vital for masticatory function, speech and can provide a good quality of life.<sup>8</sup> The traditional techniques for denture fabrication require a higher level of knowledge and skillful manipulation of the materials, which may lead to multiple errors during denture fabrication.<sup>9-11</sup> Moreover, the production of complete dentures using conventional techniques and materials such as monomer can cause an allergic reaction to some patients, regardless of the curing method as the residual of monomer has cytotoxic potential.<sup>12</sup> Fortunately, all of these problems have become solved following the digital workflow for denture fabrication, because milled resin pucks have very limited unpolymerized monomers,<sup>13</sup> dentures are made in highly crosslinked pucks,<sup>14</sup> and fabrication time is considerably decreased

following fully digital or even a combination of novel and traditional fabrication.<sup>15,16</sup> Furthermore, recent studies have claimed higher retention,<sup>17,18</sup> fit<sup>19</sup> of CAD/CAM than conventional denture fabrication.

CAD/CAM dentures can be fabricated within hours, whereas using conventional techniques can take days for production.<sup>22</sup> Therefore, the development of novel technologies in dentistry is allowing the clinicians to make restorations in a faster, easier and more accurate manner. New techniques in dentistry have countless applications, and the production of a completely removable prosthesis is one of them.<sup>23,24</sup> These novel techniques allow the clinician the options to fabricate complete dentures in office, laboratory or at a centralized production center.<sup>25,26</sup> Currently, the practice of making complete removable dentures using subtractive technology is becoming very common, and the literature provides reports following full digital and combination of digital and conventional methods for their production.<sup>27-30</sup> However, no clinical reports are showing complex clinical situations with patients presenting atrophic alveolar ridges. Therefore, this report aims to show a combination method of novel and traditional methods for the fabrication of CAD/CAM complete dentures for patients presenting with atrophic alveolar ridges. Moreover, this workflow could be used for clinicians with no access to CAD/CAM technology in their offices.

## Clinical Report

A forty-five years of age female patient presented to the clinic with the chief complaint “I need new dentures”. The patient claimed to have been wearing the existing complete dentures for the last 15 years. (Figures 1, 2 and 3) After a detailed evaluation, the findings were extreme alveolar ridge resorption in the maxilla and mandibular arches and diagnosed as a Class III of complete edentulism according to the American College of Prosthodontists classification. The alveolar mucosa appears healthy with adequate keratinized gingiva covering the crest of both ridges, although it seems thinner relative to the mandibular arch. (Figures 4, 5, and 6) The patient reported the extraction of all her teeth due to different reasons, such as caries and periodontal diseases at a young adult age. Due to the known pattern of maxillary and mandibular ridges resorption and loss of vertical dimension of occlusion resulted from denture teeth wear, the denture occlusion became a class III.

Treatment options were conveyed to the patient; however, treatment should start with a new set of complete dentures and then mandibular to have a fixed mandibular implant-supported prosthesis. The patient accepted and requested first to have the new set of complete dentures. She was also offered the option to have milled complete dentures, but due to the extreme alveolar ridge resorption it was suggested to have final impressions, master cast fabrication and jaw relation records using conventional techniques. The patient accepted the proposal and requested to start the treatment. Final impressions with polyvinyl siloxane material (Aquasil Ultra Smart Wetting, Dentsply Sirona, York, Pennsylvania, USA) were made using her current prosthesis as the impression trays, and it was performed following the functional technique. Impressions were poured out and master casts were fabricated with type IV stone (ResinRock, WhipMix, Louisville, Kentucky, USA). Conventional jaw relation records using record bases (Triad VLC Denture Base Material, Dentsply Sirona, York, Pennsylvania, USA) with pink wax rim (Hygienic U-Shaped Occlusal Rim Wax, Coltene Whaledent, Inc, Cuyahoga Falls, Ohio, USA) and vinyl polysiloxane bite registration (Regisil Rigid, Dentsply Sirona, York, Pennsylvania, USA) were fabricated following traditional record measurements of closest speaking space, lip support and smile line in order to obtain the vertical and vinyl polysiloxane bite registration (Regisil Rigid, Dentsply Sirona, York, Pennsylvania, USA). (Figure 7) A laboratory order form was downloaded from the company’s website and it was filled out. The clinician and patient selected the tooth shape, tooth shade, denture base shade, and anatomic features to be included in the denture base. Mounted casts, jaw relations records, and complete laboratory prescription forms were shipped to the company (AvaDent Digital Dental Solutions, Scottsdale, Arizona USA). A few days later the company provided a password to the clinician in order to log in to company’s website and the tooth arrangement and all other features requested were digitally designed, the clinician was available to digitally modify the tooth arrangement for every specific tooth if it was desired, and it also provided the option to alter the anatomic features requested in the prostheses. (Figures 8 and 9) The company mailed the prostheses the following week, and the patient was scheduled for delivery appointment. (Figures 10 and 11) The milled complete

denture prostheses were tried in, and they provided acceptable retention and stability. Pressure-indicating paste (White Pressure Indicator Paste, Pip Mizzy, Cherry Hill, New Jersey, USA) was used in order to evaluate the fit and pressure areas in the intaglio surfaces of the prostheses and no adjustments were needed. Border extensions were also assessed using disclosing wax (Kerr Corporation, Brea, California, USA). A conventional clinical remount was made in order to evaluate occlusion. No occlusal adjustments were required. Phonetics and esthetics were evaluated and the patient and clinician felt very satisfied. (Figures 12, 13 and 14) The applications within the manufacturing software allow full control over the selection of denture teeth position, shape, cuspal inclination and occlusal relationship upon centric and eccentric movements. Since the patient presented with atrophic mandibular ridge, semi-anatomic acrylic resin teeth of 15 degrees were chosen for posterior teeth, which were set over the crest of the ridge in bilateral balanced occlusal scheme to allow maximum denture stabilization upon horizontal jaw movements. The patient was seen in a follow-up appointment on the next day and no complaint regarding the prostheses was noted. The patient was satisfied with the prostheses' retention, stability and esthetics. The clinician evaluated the denture foundation areas and no sore spots were present; pressure-indicating paste was used again in order to assess the fit and pressure areas in the intaglio surfaces of the prostheses and no denture adjustment was required. One- and two-weeks follow-up appointments showed complete patient satisfaction with no need for denture adjustment following thorough intra-oral evaluation.

## Discussion

Extreme residual ridge resorption is a challenging clinical situation for the fabrication of complete dental prostheses and there are no clinical reports of CAD/CAM workflows for complete prosthesis solving this complicated situation. This workflow combines traditional and novel techniques in order to fabricate digital complete dentures in patients presenting extreme alveolar ridge atrophy. Due to the short height of the ridge, it was decided to make the conventional final impression following the functional impression technique using her current complete dentures. Making the final impression using the patient's existing denture as the impression tray has been shown to be a successful approach for atrophic ridges.<sup>31,32</sup> Conventional mounted master casts and can be either scanned by the clinician or simply mail them to the dental laboratory. Once the digital file is created, the computerized designs of the complete removal dentures are made, and the clinician can access online and have full control of the tooth shape, shade and arrangement, denture plate color and anatomical features. After the dentist approves all the features, the company ships the restorations in short time.

Wearing complete denture for several years may have adverse effects on the alveolar ridge bone as well as on the keratinized mucosa, and unstable denture wearing may cause adverse undesirable such as extreme alveolar atrophy of alveolar ridge.<sup>33-39</sup> Mandibular atrophic ridge sometimes can be so advanced that the short mandibular height<sup>40</sup> makes it almost impossible to deliver a stable and well-functioning complete dentures with conventional techniques, and as a result it leads to chewing difficulties, pain, sore spots and poor oral health-related to quality of life.<sup>41,42</sup> Unfortunately, due to high costs involving implant therapy, complete dentures still the first choice of treatment for patients with financial constraints, so it is imperative to have a well-fitting prosthesis in order to improve the patients' quality of life.

Milled complete dentures can be either fabricated all in one piece with base plate and teeth together or separated as this case report whereas the denture based is milled from a puck and the milling of the teeth from another puck. Milling both pieces separated provides higher esthetic results because there are multi-chromatic discs offering shade degradation to give high esthetics to milling of teeth. Moreover, in a situation whereas the patients break the teeth, there could be an option merely to mill the teeth and bond them to the existing plate without the need of milling a new entire base plate.

There are numerous techniques for the final impressions making in the edentulous arches.<sup>43-47</sup> This clinical situation was complex because the patient had been wearing the existing complete dentures for the last 15 years and the residual alveolar ridges in the mandible were excessively reabsorbed and atrophied. Due to the short height of the ridge, it was decided to make the conventional final impression following the functional impression technique using her current complete dentures. Making the final impression using

the patient's existing denture as the impression tray has been shown to be a successful approach for atrophic ridges.<sup>48,49</sup> Unfortunately, the patient needs to wait in the dental clinic while the clinicians pours the impression and fabricate the conventional master cast.

Milled complete dentures, including the teeth, are made out of prepolymerized resin acrylic pucks and teeth are bonded to the plate using a proprietary bonding mechanism in the milled recesses. This resin puck is produced under higher pressure and heat, so polymerization shrinkage does not happen and the porosity decreases and the adherence of *Candida Albicans* to the base plate decrease.<sup>14</sup> Polymerization shrinkage absence in the complete milled dentures results in a highly accurate denture fitting and improvement of retention.<sup>50,51</sup> The CAD/CAM company (AvaDent Digital Dental Solutions, Scottsdale, Arizona, USA) offers all the tooth shades and shapes that are available in conventional denture fabrication for the milled prosthesis. Moreover, the digital construction of the complete dentures allows the designer to define the minimal thickness of the denture base and to include anatomic features on the denture base plate. The company provides the clinician the opportunity to logging into their website to modify the teeth set-up before milling the final prosthesis.<sup>52-56</sup> The Avadent<sup>®</sup> (AvaDent Digital Dental Solutions, Scottsdale, Arizona, USA) order form demands the clinician to select the type of occlusal scheme, tooth shade, denture base colour, the set-up of position of the anterior teeth, and optional anatomical details for the denture base. The type of occlusal schemes offered are the anatomical, lingualized and flat-on-flat, which resembles the options provided by traditional denture teeth companies. The denture base color options include light shade, original, standard, medium and extra dark; these shades could be selected to match the patient's gingival color.

The anterior teeth position and arrangement are also available options for the clinician and patient, it offers the regular set-up, and other options such as flared out central incisors, rotated lateral incisors, palatalized lateral incisors, with small overlap among them, and with small diastemas between all anterior teeth. The extra anatomical options for the denture base include the root prominence, stippling, rugae, gingival staining, frenum depth to match impression, posterior palatal seal, buccal roll and engraving the patients name on the base. The company (AvaDent Digital Dental Solutions, Scottsdale, Arizona) also offers a wide variety of teeth shape and shades including the designs of the traditional denture teeth.

Trying to incorporate new technology or clinical techniques can be challenging because clinician needs to become familiar with the software and operating equipment by the dental laboratories to maximize the dental care options for patient care. Due to the investment in novel equipment, laboratory costs may be increased compared with conventional methods.<sup>57</sup> The laboratory companies may offer the clinical non-color trial dentures before the milling of the final prostheses however those trial dentures also have extra costs and its try-in will require an additional appointment for the patient. A previous study comparing the trueness fit of the intaglio surface of conventional and CAD/CAM dentures demonstrated significant improvements for the conventional prostheses.<sup>58</sup> However, as technology improves, newer studies have shown improvements of the CAD/CAM prosthesis.<sup>18</sup>

Several studies have indicated that prosthodontic management of anthropic mandibular ridges can be very challenging.<sup>59,60</sup> The present case report successfully combines the advantage of CAD/CAM technology and traditional clinical recording methods for the construction of complete dentures in atrophic alveolar ridges. The presented workflow is completely functional because the clinician does not need to have either an intra-oral or laboratory scanner to offer CAD/CAM dentures to patients. Following this protocol, the clinician can do conventional final impressions, jaw relation records and mounting, then it can be either sending those mounted records to the laboratory in order to fabricate CAD/CAM dentures. If the dental office has a laboratory scanner, the records could be scanned and the STL file would be sent to the company. The combination of this workflow provides the necessary critical information of maxillomandibular relationship with conventional techniques and the improved material properties and fit of the milled dentures.

## Conclusion

Combining traditional and novel technology for CAD/CAM complete dentures can provide clinically acceptable results for complex clinical situations such as extreme alveolar ridge atrophy. Conventional impression



techniques for the impression of the denture foundation areas can accurately capture all features and novel CAD/CAM manufacture offers improved denture materials and enhanced fit, retention and stability of the prostheses. The presented clinical protocol may be followed in compromised clinical situation whereas a full digital workflow may able to be performed.

## **Autor Contribution**

*Conceptualization:* Jurado CA, Sayed ME, Kaleinikova Z.

*Data Curation:* Hernandez A, Chin-Chuan F, Villalobos Tinoco J.

*Project Administration:* Alresayes S, Tsujimoto A, Sayed MA.

*Software:* Chin-Chuan F, Villalobos Tinoco J, Hernandez A.

*Writing Original:* Jurado CA, Alresayes S, Tsujimoto A.

*Writing -Review and Editing:* Kaleinikova Z, Chin-Chuan F, Tsujimoto A.

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## Figure Legends

Figure 1. Initial complete dentures frontal view.

Figure 2. Initial complete dentures lateral view.

Figure 3. Initial smile.

Figure 4. Maxilla.

Figure 5. Mandible.

Figure 6. Initial frontal view without dentures.

Figure 7. Conventional maxillo-mandibular-relationship record.

Figure 8. Digital tooth positioning.

Figure 9. Digital tooth set-up.

Figure 10. Milled complete dentures frontal view.

Figure 11. Milled complete dentures lateral view.

Figure 12. Final complete dentures frontal view.

Figure 13. Final complete dentures lateral view.

Figure 14. Final smile.















