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Case Report

Dentistry Section

Fabrication of Distal Extension Removable Partial Denture with Surveyed Crown and Altered Cast Technique: A Case Report

AYMAN AL-OULABI[1], AZIRRAWANI ARIFFIN[2], YANTI JOHARI[3]

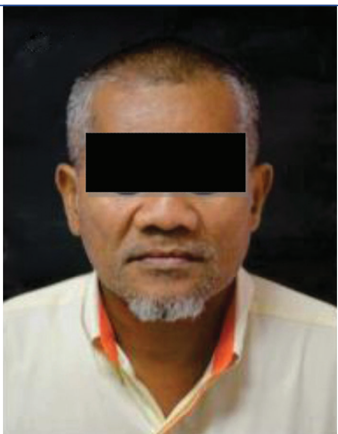
ABSTRACT

Support and stability for a Removable Partial Denture (RPD) are difficult to achieve in a distal extension edentulous ridge and are even more compromised in reduced dentition. The combination of the altered cast technique and milled crown in removable partial denture fabrication would greatly enhance support by redistributing the load more effectively. However, it is not routinely practiced due to the complexity of the treatment and the lack of emphasis in dental curriculum. In the present case of a 54-year-old male, despite several attempts at wearing the denture, the patient was unable to tolerate it. The atrophic mandibular ridge and poor inclination of the abutment tooth seemed to be complicating factors. Therefore, the prosthesis required some modifications. The present case report highlights the Applegate altered cast technique, which can be deployed with a milled crown, including the clinical and laboratory stages involved. This might help to overcome the problems encountered with distal end saddle dentures, making them more tolerable to patients.

Keywords: Abutment, Alveolar ridge, Casting, Dental crown, Dental prosthesis, Denture stability, Surveyor

CASE REPORT

A 54-year-old male was referred to the postgraduate prosthodontic clinic at Hospital Universiti Sains Malaysia with complaints of missing back teeth and chipping of his front teeth due to chewing. His concerns were to replace the missing teeth with fixed prostheses, if possible, and enhance the appearance of his anterior teeth and smile in the most painless way possible. The patient was not satisfied with several sets of removable acrylic partial dentures that were made previously due to discomfort and soreness and had been without any dentures for more than five years. He had been partially edentulous for more than 10 years. He was medically fit and well with no allergies to medications or materials. Extraoral examination revealed no abnormalities except reduced lower facial height [Table/Fig-1].



[Table/Fig-1]: Reduced lower facial height with prognathic mandible.

Upon examination, it was noticed that the tooth surface loss on the upper and lower anterior teeth [Table/Fig-2a,b] was due to constant chewing activity and loss of posterior tooth support, which led to a pseudo Class III bite. Apart from "chipping" on all the anterior upper teeth, multiple carious lesions were also noticed on teeth #13, 12, 11, 21, and 22 [Table/Fig-2a]. Tooth #13 presented with cervical discolouration [Table/Fig-2c]. The Occlusal Vertical Dimension (OVD) was reduced by 5 mm. The interocclusal space was inadequate to replace the missing teeth #14, 25, 26, 27, 37, 35, 34, 44, 46, 47, and to restore the short anterior teeth on both arches [Table/Fig-2d,e].

[Table/Fig-2]: Intraoral photographs upon presentation: a) Multiple carious lesions on upper anterior teeth; b) Minimal tooth surface loss on lower anterior teeth; c) Discoloured tooth 13 and inadequate interocclusal space for teeth replacement; d) Reduced occlusal stability leading to anterior crossbite; e) Inadequate occlusal clearance.

Further investigation revealed that tooth #13 was unresponsive to Electric Pulp Testing (EPT) and periapical radiograph revealed that the tooth has necrotic pulp with asymptomatic apical periodontitis, while tooth #12 has been endodontically treated [Table/Fig-3].

[Table/Fig-3]: Periapical radiograph of teeth 12 and 13.

Stage 1: Stabilisation and Intermediate Phase

The objectives of this phase were to stabilise the teeth with periapical pathology, restore the aforementioned carious teeth, and re-establish the new OVD. Treatment modalities involved root canal treatment on tooth #13, followed by post placement on teeth #12 and 13, restorations of all upper anterior teeth presented with carious lesions and chipped tooth surfaces with nanohybrid composite, Filtek Z250XT (3M ESPE, USA), using the vacuum stent made from the diagnostic wax up to enhance the aesthetics. After the completion of the composite resin build-up, interim acrylic dentures for both arches were provided at the newly restored OVD throughout the stabilisation phase to improve mastication and function [Table/Fig-4]. During the six-month period of wear, the patient reported some discomfort, and adjustments were done twice using soft reline material.

[Table/Fig-4]: Intraoral frontal view after stabilisation phase with upper and lower acrylic dentures in-situ.

Stage 2: Restorative and Definitive Phase

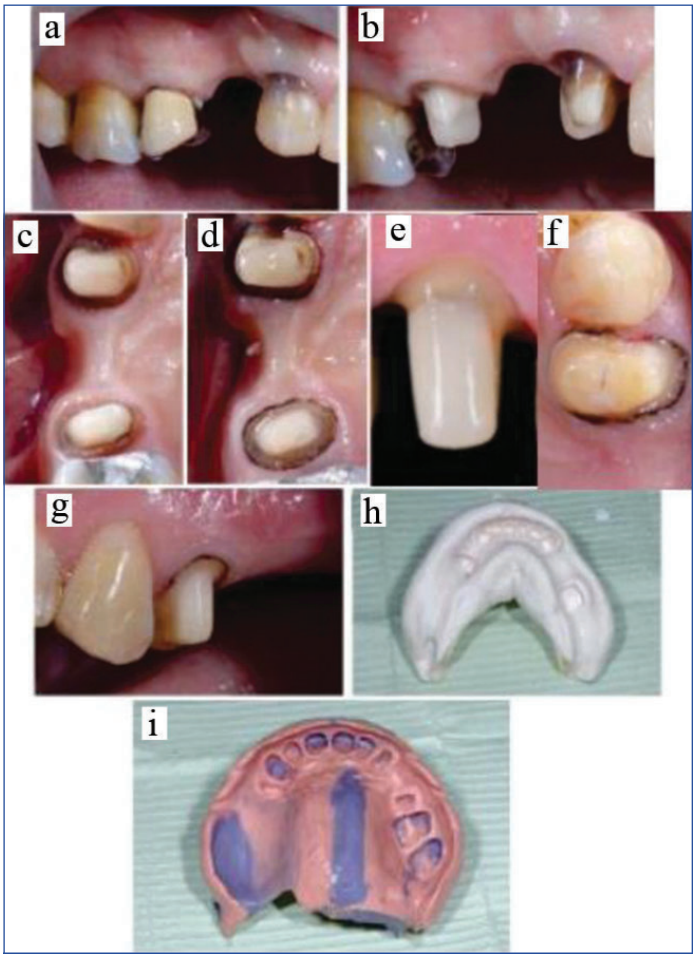
After four months of subsequent reviews and the stabilisation stage, the definitive restorative phase was initiated. For the definitive treatment plan, dental implants were suggested to the patient due to good bone quality and quantity; however, they were declined due to the involvement of surgical procedures and financial burden.

The patient requested a fixed prosthesis option where possible. Taking this into account, the upper removable acrylic denture was converted to fixed prostheses. A fixed-fixed conventional bridge from teeth #13 to 15 was planned to replace tooth #14, and a cantilever bridge from tooth #24 to replace tooth #25 was advocated. The existing Porcelain-fused-to-metal (PFM) crown on tooth #15 was sectioned using a tungsten carbide bur [Table/Fig-5a]. The tooth structure appeared to be sound and adequate to be converted as a retainer for the bridge. The preparation of tooth #15 was refined, and tooth #13 was prepared for a PFM bridge [Table/Fig-5b-d]. Tooth #12 was also prepared for a PFM crown since it has undergone root canal treatment with post placement [Table/Fig-5e]. Tooth #24 was prepared to be an abutment for a cantilever bridge to replace tooth #25 [Table/Fig-5f,g]. The shade of the teeth was selected.

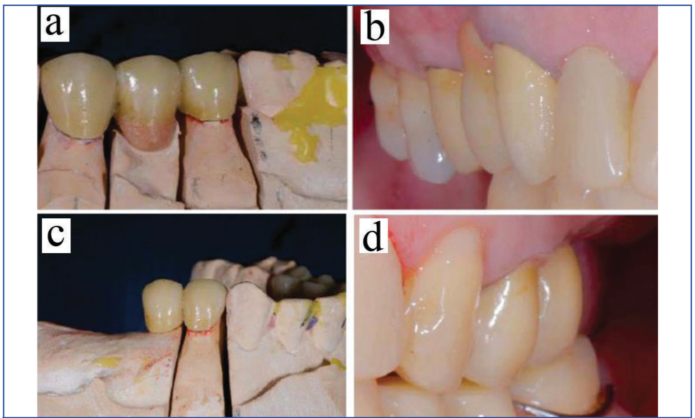
Impressions of the preparations were taken using Polyvinyl Siloxane (PVS) monophase and light body, Examix™ NDS (GC, Japan) as shown in [Table/Fig-5h,i]. The facebow and jaw relation were recorded using Exabite NDS (GC, Japan). Temporisation of teeth was done using a putty index (3M ESPE, USA) and bisacryl composite, Protemp 4 (3M ESPE, Germany), and were cemented using zinc oxide non eugenol temporary luting cement, Freegenol (GC, Japan).

The prepared casts were mounted on a semiadjustable articulator, Stratos 200 (Ivoclar Vivadent, Liechtenstein) for the fabrication of the prostheses.

Once completed, the prostheses were inserted and cemented after some occlusal adjustment and approval from the patient. The



[Table/Fig-5]: Tooth preparation for fixed-fixed and cantilever bridges on maxillary arch: a) Previous crown on tooth #15; b) Crown on tooth 15 removed and tooth preparation was refined and prepared for bridge retainer; c,d) Occlusal view of preparation of abutment teeth #13 and 15; e) Post core build up and crown preparation on tooth 12; f) Occlusal view of tooth #24 crown preparation for cantilever bridge; g) Buccal view of preparation of cantilever bridge #24 to 25; h) Lower impression; i) Final impression for the crown and bridge preparations.



[Table/Fig-6]: Issue stage of the fixed-fixed bridge for teeth #13-15, cantilever bridge for teeth 24 and 25 and crown for tooth 12: a) Buccal view of the PFM bridge of teeth 13-15 fitted on die cast; b) Buccal view of the PFM bridge for teeth 13-15 and crown for tooth 12 postcementation. Note the pink porcelain added to the pontic to mimic natural appearance of the gingiva; c) Buccal view of the PFM bridges for teeth 24-25 fitted on die cast; d) Buccal view of the cantilever PFM bridge post cementation.

cemented prostheses on both sides are shown in [Table/Fig-6a-d]. The mandibular acrylic partial denture was adjusted to fit over the newly cemented upper bridges and crown [Table/Fig-7]. At this stage, the treatment of the maxillary arch was completed, and the treatment continued with the mandibular arch.

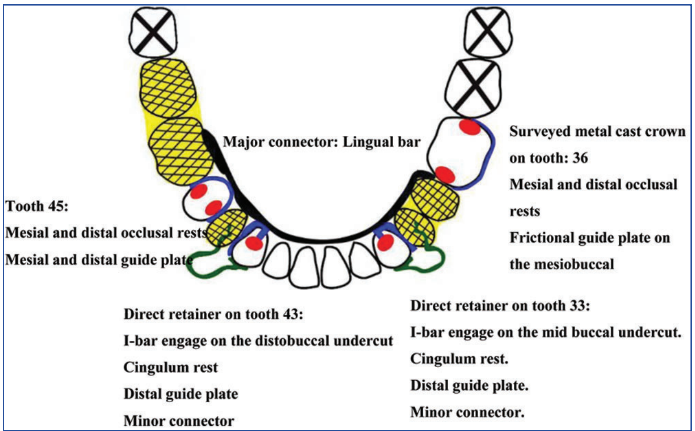
Stage 3: Planning and Construction of Surveyed Crown

Contrary to that, a fixed prosthesis is not feasible for the mandibular arch. The models were surveyed using a surveyor (Paratherm Dentaurum) to determine favourable undercuts, guide planes, and

[Table/Fig-7]: With lower acrylic denture in-situ after cementation of the crown and bridge work on maxillary arch.

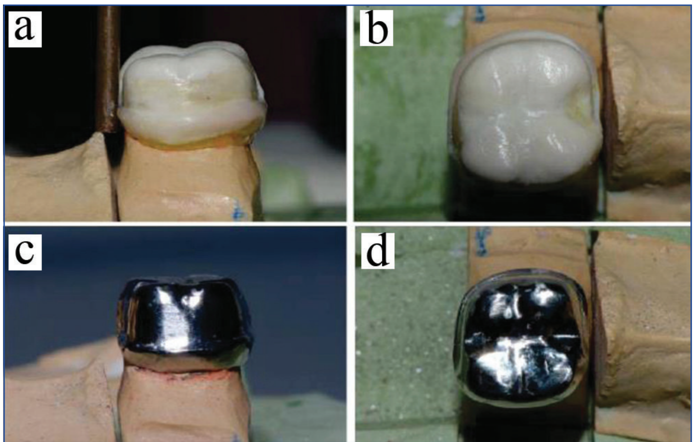
[Table/Fig-8]: Preoperative view- defective composite resin and lingual inclination of tooth 36.

the path of insertion. After surveying, it was noticed that tooth #36 was lingually inclined. This would have interfered with denture insertion later. Additionally, it also had a defective composite restoration [Table/Fig-8], which could have fractured from the loading exerted over the rest area from the Cobalt-Chrome (CoCr) denture. Consequently, a milled metal crown was incorporated on tooth #36 to correct its angulation and to enhance the support, retention, and stability [1]. A metal crown was chosen due to its durability, conservative preparation, and strength as the terminal abutment tooth. The design prescription with a clearly labelled proforma for the mandibular CoCr RPD is shown in [Table/Fig-9].

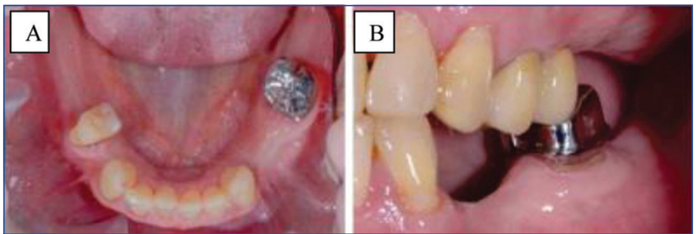


[Table/Fig-9]: The design prescription with labelled proforma for mandibular cobalt-chrome partial denture.

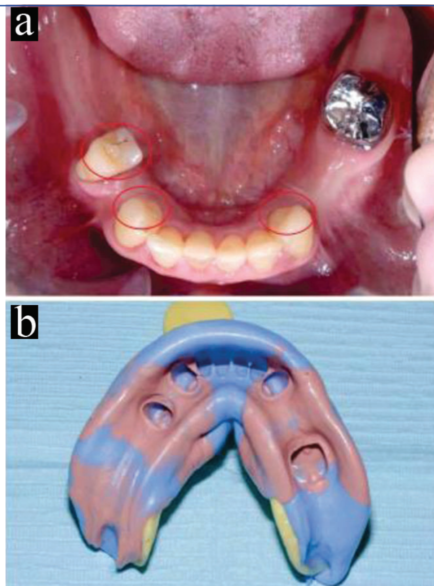
The amount of reduction for the milled crown is as follows: 0.5 to 1 mm occlusal reduction (more reduction over the mesial and distal rest areas), 1 mm buccal reduction (to allow more space for the metal crown and cobalt-chrome framework later), and 0.5 mm lingual reduction. The impression of the preparation was taken using Polyvinyl Siloxanes (PVS) monophase and light body, Examix™ NDS (GC, Japan). The bite was recorded using Exabite NDS (GC, Japan). Temporisation of the teeth was done using a putty index (3M ESPE, USA) and Bisacryl composite, Protemp 4 (3M ESPE, Germany). The temporary crown was cemented using zinc oxide non eugenol temporary luting cement, Freegenol (GC, Japan). A crown wax pattern with the incorporation of guide planes was made on the die cast to improve its contour [Table/Fig-10a,b]. The mesial and distal occlusal rests were joined together in a manner of a semiprecision attachment to direct the loading more effectively and reduce the movement of the abutment tooth [2]. The rest areas were made clear of contact with the opposing teeth. The metal crown was then cast using the lost wax technique [1], as shown in [Table/Fig-10c,d], and then cemented with a self-adhesive resin cement, Rely X Unicem (3M ESPE, Germany). [Table/Fig-11a,b] represent the milled cast crown cemented in-situ. The occlusion was verified again with shimstock and articulating paper to ensure the existing contact with the opposing tooth at the current OVD was maintained.



[Table/Fig-10]: Planning of surveyed crown on abutment tooth 36; a) Frontal view of surveyed crown in wax pattern after milling; b) Occlusal view of surveyed crown in wax pattern after milling; c) Frontal view of surveyed crown after casting; d) Occlusal view of surveyed crown on the die cast.



[Table/Fig-11]: Postcementation view: milled crown in-situ.



[Table/Fig-12]: Abutment teeth preparations and impression making: a) Occlusal view of rest seat preparation before impression making; b) Final impression using light body and medium body PVS.

Stage 4: CoCr Framework Fabrication Procedure

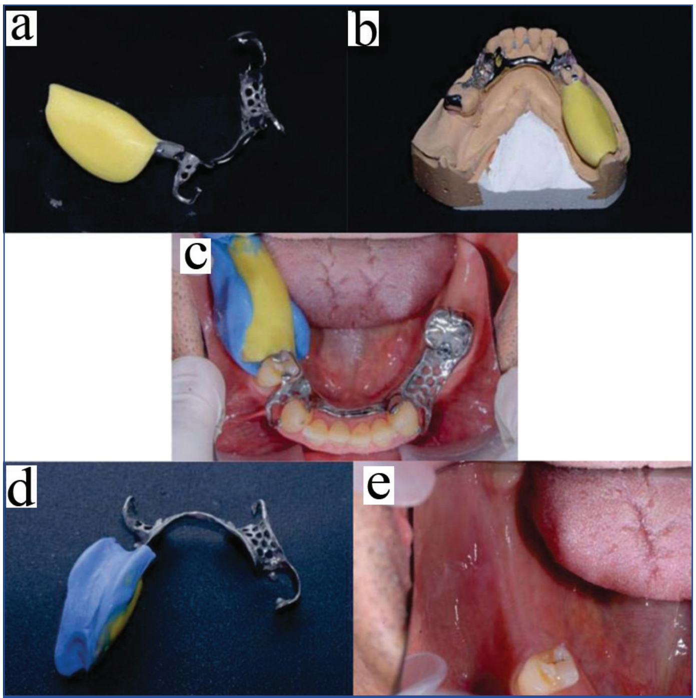
Rest seat and guide plane preparations were done on the other abutment teeth #33, 43, and 45 [Table/Fig-12a] before making the final impression of the mandibular arch using a self-cure acrylic Trayplast (Vertex, Netherlands) special tray with light and medium body PVS Examix™ NDS (GC, Japan) as shown in [Table/Fig-12b]. The master cast was obtained using type 4 dental stone (Saint-Gobain Formula GmbH, Germany). The undercuts were blocked with wax (Yeti CUTEX, Germany) before it was duplicated using agar to produce a refractory cast for the design wax pattern. The framework was cast with remamium® CoCr alloys (Dentaurum), finished, and ready for trial insertion in the patient's mouth. The framework was assessed for its passive fitting, good adaptation, as well as retention and occlusal clearance intraorally [Table/Fig-13]. The support from the rests and major connector was particularly essential in the Applegate technique to ensure correct seating and positioning of the framework while taking a secondary impression of the saddle area later [2]. The framework was sent back to the laboratory for a special tray addition over the saddle area.

[Table/Fig-13]: Occlusal view of the lower metal framework in-situ during trial insertion. Good adaptation under the rest and major connector components are essential for support of the framework during impression making over the distal extension area later.

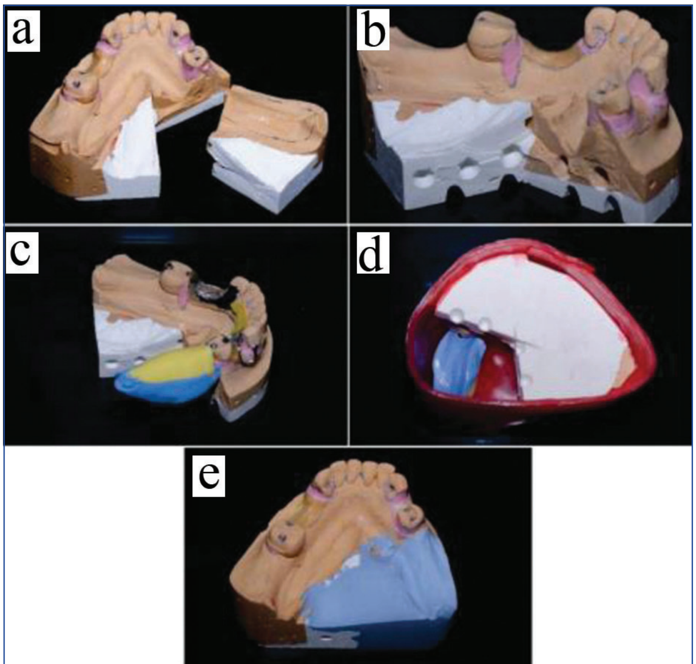
Stage 5: Altered Cast Impression Technique

About 1.5 mm thickness of wax with no stops was laid over the distal alveolar ridge and lingual tissue areas before the framework was fitted accurately on the working model. An acrylic resin custom tray was attached to the mandibular metal framework overlying the wax area using self-cure acrylic, Trayplast (Vertex, Netherlands). The extension of the tray border was trimmed and polished so that the flange was 2 mm short from the vestibule [Table/Fig-14a,b]. Then, the framework with the custom tray was checked inside the patient's mouth. After coating the tray with a layer of adhesive ExaFlex (GC, Japan), single-step border moulding and final impression were made using medium body PVS, Examix™ NDS (GC, Japan). Special care was given while making the impression; finger pressure was applied only to the parts of the framework (rests) that came in contact with the teeth [Table/Fig-14c-e].

In the laboratory, the cast was altered. Two saw cuts were made slightly perpendicular; the first cut was made 0.5-1.0 mm distal to the lower left second premolar and perpendicular to the edentulous ridge, extending to 6.0 to 7.0 mm medial to the lingual vestibule. The second cut was made 6.0 mm medial and parallel to the edentulous ridge, running from the most posterior part of the cast connecting to the most medial part of the first cut [Table/Fig-15a]. Then, mechanical means of retentions were made on the stone with a round bur to aid in the retention of the newly poured stone prior to seating the framework on the cast [Table/Fig-15b]. The complete positioning of the framework on the model was essential before securing it in place with sticky wax [Table/Fig-15c]. Finally, the impression was poured with Type 4 die stone (Saint-Gobain Formula GmbH, Germany) after beading and boxing procedures were done [Table/Fig-15d,e].



[Table/Fig-14]: The custom acrylic tray for final impression for altered cast technique: a) Mandibular metal framework with the acrylic resin custom tray attached over the saddle area; b) Fitting of the framework with the acrylic tray on the master cast; c) Fitting of the framework with the acrylic resin custom tray while taking the impression using PVS; d) Final impression of the lower left ridge area; e) Anatomy of tissue on right free end saddle area.

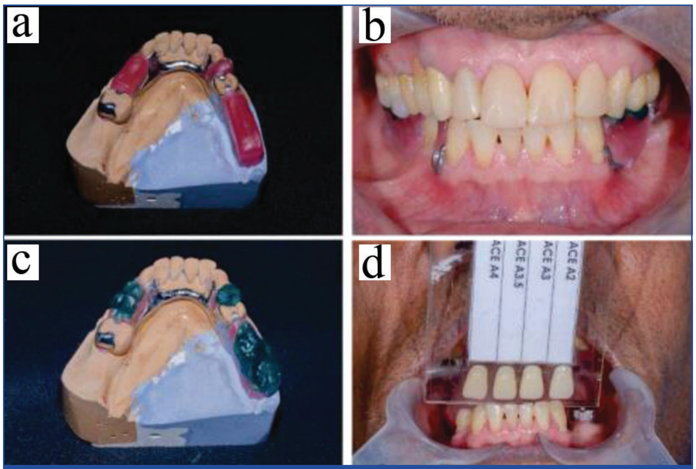


[Table/Fig-15]: Laboratory procedures of altered cast technique: a) The master cast with two saw cuts slightly perpendicular to each other on lower right saddle area; b) The cut surface of the cast with the mechanical means of retention; c) Seating of the framework on the master model with yellow sticky wax; d) Final impression with beading and boxing; e) Final master cast after altered cast impression technique/

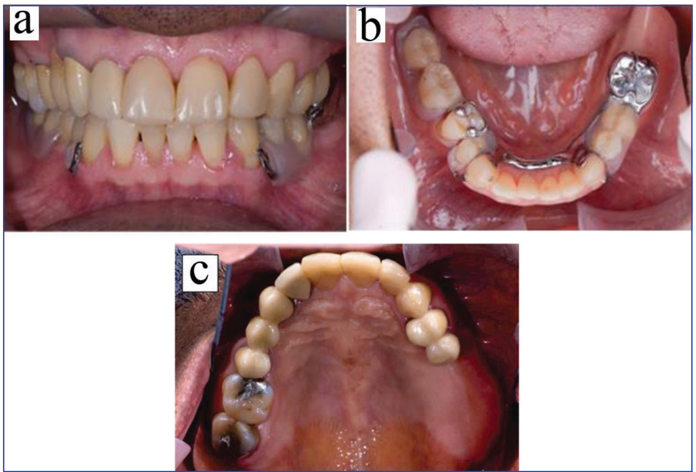
Stage 6: Jaw Relation Registration, Try in and Denture Issue

A wax occlusal rim was attached to the saddle areas [Table/Fig-16a]. The framework with the occlusal rim was seated inside the patient's mouth. The wax was adjusted to the current OVD, and the jaw relation was recorded with Aluwax [Table/Fig-16b,c]. The shade and size of the teeth were selected [Table/Fig-16d]. Subsequently, the casts were mounted on a semiadjustable articulator (Stratos 200, IvoclarVivadent, Liechtenstein), followed by the teeth setting procedure.

During the teeth try-in, the patient was satisfied with the aesthetics. The denture was sent to the laboratory for processing. It was then issued with no adjustments required. The fitting and retention of



[Table/Fig-16]: Bite registration stage: a) The framework with occlusal rim; b) The framework with occlusal rim fitted in-situ bite; c) The framework with occlusal rim after bite registration using Aluwax fitted on the master cast; d) Selection of the teeth shade and size.



[Table/Fig-17]: Postinsertion intraoral photographs: a) Frontal view; b) Lower occlusal view; c) Upper occlusal view.

the lower denture were excellent [Table/Fig-17a-c]. He was satisfied with his teeth and prosthesis. Postinsertion instructions were given. The patient was advised to chew his food in small bites as he had not been wearing dentures for some time. Subsequent periodic examinations of patients were carried out up to six months without any necessary adjustments.

DISCUSSION

The Kennedy Class 1 classification of partial edentulism in the mandibular arch is by far the most challenging and prevalent condition that dentists face [3]. Many factors must be carefully considered when designing removable prostheses for these groups of patients. In the present case, it was decided not to replace the lower left edentulous area. Conversion to a Kennedy Class 2 partial denture was decided to increase the patient's comfort and acceptance towards wearing dentures after several unsuccessful attempts. The fundamental principle in the fabrication of any removable prosthesis is achieving good support, as in the present case [3]. Therefore, to achieve this, a combination of the altered cast technique and a milled crown has been proven to increase patient satisfaction and adaptability towards wearing dentures.

The patient refused implants due to financial burden. The altered cast technique aimed to minimise the displaceability of the overlying mucosa in the posterior right region and the abutment teeth during function, as highlighted by Applegate [4]. In doing so, the rotational forces of the denture on the abutment teeth and the traumatisation of the alveolar ridge due to destructive leverage might be minimised [5]. Hence, addressing the problems he encountered with his previous set of dentures and the interim acrylic denture that were fabricated previously.

The decision to fabricate a milled crown on the lower left first molar was made due to several factors. All of which revolved around reducing the movement of the denture base over the edentulous ridge area. As the tooth was lingually tilted, it was anticipated that the path of insertion for the RPD and the survey line might have posed some problems. The milled crown provides solutions to these problems as it improves the angulation of the tooth to facilitate the insertion of the RPD and at the same time offers additional retention through the incorporated guide planes which direct the functional loading along the long axis of the tooth favourably [3,6]. This is particularly important since tooth #37 is a terminal abutment. Apart from that, the milled crown has improved the contour of tooth #37. Originally, the location of the survey line on the lingual was unfavourable since it was in proximity to the occlusal table.

The denture design for tooth #36 was made claspless to prevent leverage torquing effects on the abutment from the contralateral saddle area. The bracing effect that the framework yields over the crown would help improve its stability as well as support [7]. Igarashi Y, pointed out in their previous studies that less prosthesis movement and abutment mobility were observed on retainers with a more rigid connection [8-10]. This is consistent with the author's clinical observation and the patient's feedback.

The disadvantages of these two techniques are that they require clinical experience, additional time, and cost due to extra clinical sessions and are technique-sensitive. Clearly written prescriptions and effective communication with dental technologists are mandatory to achieve precision for optimal treatment outcomes.

In the present case, a conventional impression method, as highlighted by Applegate, was adopted with slight modification. Additional silicone material was used instead of wax. Lynde proposed a simplified method to reduce clinical visits by combining the altered cast impression and occlusal registration in the framework try-in clinical visit. This method involved additional instruction to fabricate a detachable custom tray on the framework to the laboratory once the framework had been constructed. Once the fitting of the framework was confirmed and satisfactory, the detachable custom tray was attached to the framework using cyanoacrylate adhesive. Then an impression was made, kept in-situ, and occlusal registration material was added on top [11]. However, this might increase the complexity of the procedure and increase the chances of clinical errors, plus more technical experience is needed to pour the impression and maintain proper OVD during cast mounting.

Most studies related to the materials used in impressions are in-vivo studies [12,13]. Regarding the vertical displacement of the RPD on occlusal loading, Holmes JB found that the altered cast technique exhibited significantly minimal vertical movement using a stock tray with alginate compared to a conventional special tray with alginate impression. When comparing various materials used in the altered cast technique, Korecta wax IV (Kerr, USA) exhibited the least vertical movement of the denture, followed by metallic pastes such as zinc oxide and injectable silicone, while alginate showed the highest denture displacement [12]. These results are consistent with the findings established by Leupold RJ et al., in 1992 [13]. They concurred that the altered cast impression technique with light body polysulfide had the least vertical denture movement (0.6 mm), which was significant when compared to other techniques such as border-moulded custom tray with light body polysulfide (0.79 mm) and stock tray with alginate (1.48 mm) [13].

On the other hand, Vahidi F compared different impression materials without the use of the altered cast technique. His study showed that polysulfide impression material exhibited some tissue displacement but not as high as Korecta wax IV (Kerr, USA) and alginate [14]. These results indicate that the impression material plays a role in soft tissue displacement, not only tissue resiliency. Hence, this evidence corroborates that the altered cast technique can enhance support and stability, especially in distal extension bases, by further minimising the displacement of tissue and movement of the denture base during function compared to conventional impression techniques [15,16].

All studies mentioned above had small sample sizes (n<10). Frank RP et al., conducted a study with the largest sample size among other studies (n=72), including a one-year follow-up [17]. This is the only study that took into consideration the patient's satisfaction and the prevalence of soreness. They reported that the altered cast technique using polyether and polysulfide had significantly less space difference (0.15 mm) between the ridge crest and the base compared to the one-piece cast using a special tray with polyether and polysulfide.

Regarding patient satisfaction and the prevalence of soreness, they found that there is no disparity in support, and similar adjustment sessions were carried out during the one-year follow-up [17]. In terms of the survival of the abutment teeth between the altered cast technique and conventional impression technique, no detrimental effects were reported after the one-year follow-up, and there were no changes in the gingival index, mobility, and sulcus depth recorded in the study [17].

Currently, there is a lack of strong evidence, and more randomised clinical trials with large sample sizes and longer follow-ups are needed to establish a recommendation [18]. Furthermore, other clinical parameters such as alveolar ridge changes and periodontal changes of the abutment teeth need to be considered, not just the vertical displacement of the tissue or the denture [17].

Despite the limited evidence, based on the present case, the combination of a milled crown and the Applegate altered cast technique is one of the practical techniques that can be applied to enhance the support and stability of the CoCr RPD in the management of distal extension edentulous ridges. It would be advisable to implement these techniques in dental curricula, as, thus far, this technique in some cases might offer better outcomes compared to other impression techniques and one-piece casts.

CONCLUSION(S)

A CoCr RPD can be a viable alternative to an acrylic partial denture to improve stability in a long-span free-end saddle denture by incorporating the altered cast technique and surveyed crown techniques.

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PARTICULARS OF CONTRIBUTORS:

1. Private Practioner (Prosthodontist), Dubai, United Arab Emirates.
2. Senior Lecturer and Consultant, Prosthodontic Unit, School of Dental Sciences, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia.
3. Senior Lecturer and Consultant, Prosthodontic Unit, School of Dental Sciences, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Azirrawani Ariffin,
Prosthodontic Unit, School of Dental Sciences, Universiti Sains Malaysia,
Health Campus, Kubang Kerian, Kelantan, Malaysia.
E-mail: wani@usm.my

PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Jul 12, 2021
- Manual Googling: Jul 30, 2021
- iThenticate Software: Sep 04, 2023 (12%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:

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- For any images presented appropriate consent has been obtained from the subjects. Yes

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