FULL MOUTH REHABILITATION USING CAD-CAM SURVEYED ZIRCONIA CROWNS AND A REMOVABLE PARTIAL DENTURE (CASE REPORT)

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ABSTRACT

BACKGROUND: Many clinical cases present with bilateral edentulous area and in a majority of those cases implant restoration may not be feasible. Consequently, the use of a conventional metallic partial denture is still in demand. With the rise of attention to physical appearance in our daily life, esthetics became an integral part of dental practice. Therefore, patients request esthetic restorations anteriorly conditioned with not compromising on function. Amongst the most popular esthetic and functional restorations is zirconia. Zirconia has proven to be able to withstand functional and occlusal stresses without compromising the cosmetic effect required from a tooth-colored restoration. Which is what makes it ideal for use as surveyed crowns to support partial dentures.

OBJECTIVES: This case report aimed at highlighting a technique to restore a partially edentulous patient using a metallic partial denture supported by CAD-CAM surveyed zirconia crowns.

KEYWORDS: Surveyed crowns, zirconia, partial denture, digital smile design.

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INTRODUCTION

Many clinical scenarios require the conjugation of optimum esthetics without compromising function. The use of computer-aided design and computer-aided manufacturing (CAD-CAM) technology and tooth-colored esthetic crown materials for removable partial denture (RPD) abutment has been established only decade ago. Prior to the rise of ceramic crowns, metal-ceramic restorations were regarded as the gold standard material owing to their acceptable properties, in terms of esthetics, and marginal and internal adaptation (1-4). The popularity of ceramic crowns has improved because of superior esthetics, ease of fabrication, biocompatibility with the oral environment (5,6,7). Consequently, zirconia-based ceramics have been widely used in restorative and prosthetic dentistry (8-10). Especially in complex cases demanding an esthetic outcome for the anterior zone as well as functional stability to accommodate a cast metallic partial denture framework in the posterior edentulous area (11-15).

Surveyed crowns are single crowns or fixed partial denture retainers that are used to support clasp-type removable partial dentures (16). The surveyed crown is an imperative part of mixing fixed and removable prosthodontics (17).

Methods of constructing ceramic surveyed crowns using CAD-CAM technology have been designated (11-16). Removable partial denture abutments have been reported in which rest seats and guiding planes were made of either sintered aluminum oxide or zirconia (11-14). Surveyed crowns should aid in force distribution from the denture on abutment teeth and enhancing the longevity of both the supporting structures and partial dentures (18,19).

A rest seat, is intended to accommodate the cast rest portion of the partial denture framework, providing vertical support and directing the masticatory and occlusal forces towards the long axis of the abutment tooth (19,20). The form and design of the abutment tooth and rest seat preparation should make allowance for efficient masticatory force transmission, retention, and stability of supporting structures (19,21,22).

The following case report describes a technique for full mouth rehabilitation. The anterior teeth were restored using full anatomic monolithic surveyed crowns. A cast clasp type removable partial denture was provided to replace the missing posterior teeth.

MATERIALS AND METHODS

A 42-year-old female patient was referred to the comprehensive clinic in the faculty of dentistry pharos university. The patient mainly complained of poor esthetics anteriorly owing to her broken down teeth and inability to chew properly posteriorly due to previous extractions of posterior

teeth. Maxillary and mandibular preoperative condition are seen in Figure 1. After preliminary examinations and diagnosis using all the necessary diagnostic aids (history taking, extra and intra-oral examinations, mounted diagnostic casts, radiographs) a treatment plan was set.

For the maxillary anterior teeth, the treatment of choice was root canal treatment, post and core build up followed by full coverage esthetic crowns.

For the maxillary posterior teeth replacement, several options were assessed. Dental implants were the first option to replace the missing teeth but it was ruled out attributable to the patient's preference due to refusal of surgical intervention, financial and time constraints.

For the mandibular anterior teeth scaling and stain removal followed by composite fillings was selected. A conventional cast clasp removable partial denture was selected to replace both the posterior maxillary and mandibular teeth.

Phase I consisted of examinations, diagnosis and finalizing the treatment plan. Scaling, polishing and oral hygiene instructions were provided to the patient.

As part of the patient motivation and involvement in the treatment plan, digital smile design of the anterior teeth was done conforming with the patient's esthetic demands, to simulate what the final restoration would look like. (Figure 2)

Phase II - the disease control phase consisted of:

Caries removal and endodontic treatment of teeth #13, 12, 11, 21, 22, 23

Composite fillings for teeth #47, 43, 42, 41,31,33,34

Endodontic re-treatment tooth #24

Construction of a transitional denture prior to crown preparation was done and inserted at the purposed vertical dimension to maintain the VDO.

Post and core build up followed by crown preparation for #15,14 13,12,11,21,22,23,

Crown preparation was carried out by performing a subgingival deep chamfer finish line with rounded internal line angles to accommodate the zirconia crowns (23).

Final impression for maxillary and mandibular arches using PVS putty and wash impression technique. Followed by bite registration using addition silicone PVS while the transitional denture was in place.

Chair side provisional restorations were provided using auto-polymerized composite resin structure temporization material with the aid of the DSD previously done.

Phase III (restorative phase):

Computer aided designing of the maxillary crowns:

After pouring of the model, a desktop bench scanner was used (Ceramill® Lab 600) and a virtual model of the prepared arches was obtained.

The design of the crown retainers and the rest seat preparations were done according to the following guidelines (23,24,25): (Figure 3)

Rest seats:

occlusal rest – triangular in shape with rounded corners, floor inclined towards the center, confined to 1/3 the occlusal surface, 2.5 mm at the marginal ridge 0.8 mm

cingulum rest – V shaped seat above the convexity of the cingulum extended mesiodistally along the diameter of the crown, 1 mm in depth

Guiding planes: 0.5 mm depth

Undercuts were emphasized for clasping

Embrasures were widened for the passage of minor connectors

*Tools used to carve the design is the attachment feature in the free form step

The finished crowns were then milled using Ceramill® Therm 3 using the following materials: (25) (Figure 4)

For the maxillary incisors: Super High Translucent Pre-Shaded blocks (shade A1) - Zolid fx ML 0/A1

For canines and premolars: Full anatomic monolithic high translucent - Zolid HT A1

Adhesive cementation of the maxillary surveyed crowns using resin bonded luting cement - self-adhesive, dual-cure resin luting cement (RelyX™ Unicem 2 Self-Adhesive Resin Cement, 3M, USA)

Surveying of casts, formulating the RPD design, filling the work authorization sheet and rest seat preparations were done in mandibular arch followed by final impressions using PVS impression material.

Metal try-in of partial denture, bite registration and facebow transfer.

Try in of partial denture with acrylic teeth.

Insertion of final maxillary and mandibular prosthesis. (Figure 5) Necessary occlusal adjustments were carried out for elimination of any high points and uniform equal intensity contacts were established. Post-insertion instructions regarding insertion, removal of prosthesis, chewing food, and hygiene measures were given to the patient (Figure 6)

Phase IV:

Follow up and recall appointments were done at 1 week, 1 month, 3 months, 6 months, 1-year intervals.

Figure (1): Preoperative intra-oral images.

Figure (2): Digital smile design

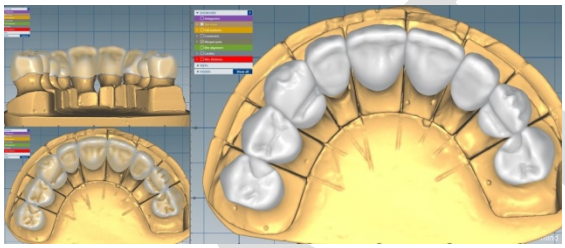

Figure (3): Design of the surveyed crowns.

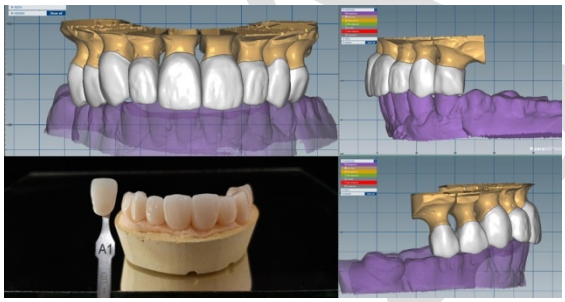

Figure (4): Final crowns.

Figure (5): Final delivery of the prosthesis.

Figure (6): Before and After.

DISCUSSION

In cases requiring a conjugation between esthetics in the anterior zone and functional replacement of lost posterior teeth, the described technique proved to be a successful option.

Traditionally when restoring missing posterior teeth specially in distal extension cases, implants have been the treatment of choice, however in this particular case it was not convenient due to patient's refusal to any surgical intervention and financial constraints.

Surveyed crowns were conventionally done using PFM crown retainers, however with the rising need for esthetics specially in the anterior zone, where the surveyed crowns are going to be placed on anterior teeth requiring high esthetic demands.

Zirconia has been gaining wide acceptance as a replacement to PFM owing to its superior esthetics and mechanical properties. Therefore zirconia has been selected as the material of choice to fulfill the esthetic demands and also to withstand the functional forces derived from the metallic RPD. (25)

Rest seats are said to be stable when prepared in enamel or restorative materials such as composite resin or amalgam. (26) Nevertheless, due to the properties of ceramic materials, especially their brittle nature, the design for the rest seats should be proper and strong enough when a monolithic ceramic crown is planned, predominantly since rests do not acclimate well to the rest seat (27). The design of the floor of the rest seat may have consequences on the stresses induced around the surfaces of the rest (28-30). Furthermore, in evaluating the fracture strength of monolithic crowns, a key factor is the thickness of the crown material. Lan et al (31) described that a thickness of 0.7 mm of a nonanatomic crown was sufficient for resisting cyclic fatigue loading at an axial and 10-degree oblique load of an implant-supported zirconia crown. In this particular case an occlusal rest seat preparation of 0.8 mm depth was accounted for. Rounding of all internal line angles

was done to insure there are no points of stress concentration.

As for the cingulum rests Manchester et al. (32) suggested that the shape of the rest seats greatly affects the strength and fracture resistance of the surveyed crowns. Cingulum rest seats with a rounded design provided more favorable fracture resistance compared to sharply shaped angles of seats in CAD-CAM surveyed crowns for removable partial dentures.

With regards to the ability of zirconia crowns to withstand the forces generated by clasp arms, Tanaka et al. (33), reported that the hardness of zirconia crowns is in fact even higher than that of Co-Cr crowns making it acceptably resistant to the friction exerted by the clasps during insertion and removal of the prosthesis. Also, the retentive force of the clasp arms was comparable in both zirconia crowns and metallic crowns.

After a 1 year follow up with no complaints. There were no reported problems with retention or stability of the partial denture. Clinical examination in recall appointments showed nothing abnormal concerning the RPD, zirconia crowns, gingival health.

CONCLUSION

The treatment option provided for this case has proven to be a reliable and successful one. It is safe to say that zirconia may become the new gold standard of dental restorations. Moving forward, the use of CAD CAM technology and up to date ceramic restorations such as zirconia in conjugation with the conventional RPD is a promising dental approach. Long term clinical applications are recommended to further objectify the results of this case

CONFLICT OF INTEREST:

The authors declare that they have no conflicts of interest.

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REFERENCES:

1. Kancyper S, Sierraalta M, Razzoog ME. All-ceramic surveyed crowns for removable partial denture abutments. J Prosthet Dent 2000;84: 400-2.
2. Walton TR. A 10-year longitudinal study of fixed prosthodontics: clinical characteristics and outcome of single-unit metal ceramic crowns. Int J Prosthodont 1999;12:519-26.
3. Spear FM. The metal-free practice: myth? Reality? Desirable goal? J Esthet Restor Dent 2001;13:59-67.
4. Reitemeier B, Hänsel K, Kastner C, Walter MH. Metaleceramic failure in noble metal crowns: 7-year results of a prospective clinical trial in private practices. Int J Prosthodont 2006;19:397-9.
5. Wettstein F, Sailer I, Roos M, Hämmerle CH. Clinical study of the internal gaps of zirconia and metal frameworks for fixed partial dentures. Eur J Oral Sci 2008;116:272-9.
6. Raigrodski AJ. Contemporary materials and technologies for all-ceramic fixed partial dentures: a review of the literature. J Prosthet Dent 2004;92: 557-62.
7. Donovan TE. Factors essential for successful all-ceramic restorations. J Am Dent Assoc 2008;139:14S-8S.
8. Manicone PF, Rossi Iommetti P, Raffaelli L. An overview of zirconia ceramics: basic properties and clinical applications. J Dent 2007;35:819-26.
9. Batson ER, Cooper LF, Duqum I, Mendonça G. Clinical outcomes of three different crown systems with CAD/CAM technology. J Prosthet Dent 2014;112:770-7.
10. Flinn BD, Raigrodski AJ, Singh A, Mancl LA. Effect of hydrothermal degradation on three types of zirconias for dental application. J Prosthet Dent 2014;112:1377-84.
11. Carracho JF, Razzoog ME. Removable partial denture abutments restored with all-ceramic surveyed crowns. Quintessence Int 2006;37:283-8.
12. Marchack BW, Chen LB, Marchack CB, Futatsuki Y. Fabrication of an allceramic abutment crown under an existing removable partial denture using CAD/CAM technology. J Prosthet Dent 2007;98:478-82.
13. Pihlaja J, Napankangas R, Kuoppala R, Raustia A. Veneered zirconia crowns as abutment teeth for partial removable dental prostheses: a clinical 4-year retrospective study. J Prosthet Dent 2015;114:633-6.
14. Joo HS, Park SW, Yun KD, Lim HP. Complete-mouth rehabilitation using a 3D printing technique and the CAD/CAM double scanning method: a clinical report. J Prosthet Dent 2016;116:3-7.
15. Patel D. Retrofitting a crown supporting a removable partial denture using “Biogenericcopy” to replicate tooth’s preoperative condition. Comp Cont Ed in Dent 2016;37:126-30.
16. Yoon TH, Chang WG. The fabrication of a CAD/CAM ceramic crown to fit an existing partial removable dental prosthesis: a clinical report. J Prosthet Dent 2012;108:143-6.
17. Chandler HT, Brudvik JS, Fisher WT. Surveyed crowns. J Prosthet Dent 1973;30:775-80.
18. Seals RR, Stratton RH. Surveyed crowns: a key for integrating fixed and removable prosthodontics. Quintessence Dent Tech 1987;11: 43-9.

19. Rehmann P, Orbach K, Ferger P, Wöstmann B. Treatment outcomes with removable partial dentures: a retrospective analysis. Int J Prosthodont 2013;26:147-50.
20. Rudd RW, Bange AA, Rudd KD, Rudd RM. Preparing teeth to receive a removable partial denture. J Prosthet Dent 1999;82:536-49.
21. Luk NK, Wu VH, Liang BM, Chen YM, Yip KH, Smales RJ. Mathematical analysis of occlusal rest design for cast removable partial dentures. Eur J Prosthodont Restor Dent 2007;15:29-32.
22. Burns DR, Unger JW. The construction of crowns for removable partial denture abutment teeth. Quintessence Int 1994;25:471-5.
23. Paek J, Noh K, Pae A, Lee H, Kim HS. Fabrication of a CAD/CAM monolithic zirconia crown to fit an existing partial removable dental prosthesis. J Adv Prosthodont. 2016 Aug;8(4):329-332.
24. Choi, Hyeong-Seob Kim*, Kung-Rock Kwon, Ahran Pae, Kwantae Noh, Janghyun Paek, Seoungjin Hong. Rehabilitation of severely worn dentition using Monolithic surveyed restoration and electronic surveying in RPD metal framework fabrication: A case report. *J Korean Acad Prosthodont 2018;56:243-9)*
25. Hajira N. Effect of Rest Seat on the *In Vitro* Mechanical Performance of Monolithic Zirconia Crowns Supporting Bilateral Free-End Removable Partial Dental Prostheses: A Pilot Study. University of Toronto. 2018
26. De Aquino AR, Barreto AO, de Aquino LM, Ferreira AM, Carreiro Ada F. Longitudinal clinical evaluation of undercut areas and rest seats of abutment teeth in removable partial denture treatment. J Prosthodont 2011;20:639-42.
27. Dunham D, Brudvik J, Morris J, Plummer K, Cameron S. A clinical investigationof the fit of removable partial dental prosthesis clasp assemblies.J Prosthet Dent 2006;95:323-6.
28. Kamposiora P, Papavasiliou G, Bayne SC, Felton DA. Stress concentrationin all-ceramic posterior fixed partial dentures. Quintessence Int 1996;27:701-6.
29. Fischer H, Weber M, Marx R. Lifetime prediction of all-ceramic bridges by computational methods. J Dent Res 2003;82:238-42.
30. Plengsombut K, Brewer JD, Monaco EA, Davis EL. Effect of two connector designs on the fracture resistance of all-ceramic core materials for fixed dental prostheses. J Prosthet Dent 2009;101:166-73.
31. Lan TH, Liu PH, Chou M, Lee HE. Fracture resistance of monolithic zirconia crowns with different occlusal thicknesses in implant prostheses. J Prosthet Dent 2016;115:76-83
32. Manchester JA, Chung KH, Brudvik JS, Chen YW. Fracture resistance of cingulum rest seats in CAD-CAM tooth-colored crowns for removable partial denture abutments. The Journal of prosthetic dentistry. 2019;1;121(5):828-35.
33. Tanaka A, Miyake N, Hotta H, Takemoto S, Yoshinari M, Yamashita S. Change in the retentive force of Akers clasp for zirconia crown by repetitive insertion and removal test. journal of prosthodontic research. 2019;63(4):447-52.