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Case Report: Veneer-retained Fixed Dental Prosthesis: A Clinical Report on Three Cases with Up to 5 Years Follow-up and Literature Review

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ABSTRACT

Replacement of a single missing tooth in the esthetic zone is a challenging clinical situation. As treatment expectations of dental patients continue to escalate, restorative dentists must consider several factors to ensure a management with optimum results. Preservation of the remaining teeth structure plays an important role in determining a suitable option for replacement of a single missing tooth. The treatment options should not only be confined to implants or lingually/palatally resin bonded bridges but also veneer-retained fixed dental prosthesis in selected cases could prove to be beneficial for the patient. This clinical report presents three cases treated with this approach and followed-up for up to five years. In addition, a review of the literature was conducted to identify the potential complications of this treatment modality.

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1. Introduction

Single tooth replacement, especially in the esthetic zone, is of significant clinical importance. This is due to both functional requirements and the necessity for harmonious integration of the restoration with adjacent soft and hard tissues. Tooth auto-transplantation and orthodontic space closure, Implant-supported restoration, fixed dental prosthesis (FDP), and resin-bonded bridge (RBB) are among the treatment approaches for this clinical situation (1, 2). Several parameters influence the decision on the appropriate treatment option. The patient's age and status of the skeletal growth, type of the occlusion, and neighboring teeth condition are some of the vital factors that should be considered during treatment planning. Additionally, the treatment cost could significantly affect the management option (3). Despite the unassailable advantages of implant rehabilitation, it cannot be used in certain clinical situations, including limited dimensions of the edentulous space, adjacent roots proximity to the implant site, and minimal available bone. On the other hand, benefits such as not requiring surgical intervention and lower cost have made conventional tooth-supported restorations a satisfactory treatment option in terms of patients' perception (3, 4). FDP has been regarded as the standard of care for some time in replacement of single and multiple missing teeth. However, it is associated with a significant amount of tooth substance loss that can be aggressive damage to sound abutments and burdens the risk of pulpal damage. These facts, along with the developments in adhesive materials, opened up for a more conservative approach known as RBB. While some authors advocated this type of treatment merely as durable provisional, different studies have shown long-term survival rate to consider it as a permanent restoration. These studies reported debonding as the most common complication (5-7). A variety of restorative materials have been employed in the construction of RBB, spanning from fiber-reinforced composite to metal alloys and high strength core ceramics. Although metal-free substructures

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solved the greyish shadow and discoloration of the abutment teeth, the choice of material has shown to have only a minor impact on the long-term prognosis of the restoration (8). Since RBB is dependent on bonding to the oral surface of the abutment tooth it is powerless in tooth color or shape correction. The esthetic result might be compromised when interdental space is present or space management is required. Likewise, patients with limited interocclusal space and short clinical crowns are not good candidates for this treatment approach. Veneer-retained fixed dental prosthesis (VRFDP) is a treatment modality that can be considered as an alternative option when these clinical situations exist.

Lithium disilicate is a synthesized glass-ceramic. While it has appealing esthetic characteristics, it features for flexural strength of up to 460 MPa. Such optimal mechanical properties made this ceramic suitable for posterior areas (9, 10). Additionally, these modern ceramics can be fabricated by the CAD-CAM technology. A significant advantage of the digital fabrication method over conventional techniques is the precise control of restoration thickness and dimensions, especially in critical areas such as connectors in FDP. Following describes the lithium disilicate glass ceramic VRFDP in three clinical situations where the common conservative treatments were not applicable.

2. Case Report

A 22-years-old male with a dental history of orthodontic treatment sought care for his missing left maxillary and mandibular first premolar teeth. Clinical examinations showed vital and non-restored teeth adjacent to the edentulous areas, as well as an excessive overbite and steep anterior guidance. The radiographic examination revealed the previous orthodontic treatment had resulted in tipped adjacent roots in both edentulous areas. Implant was rejected since the patient was reluctant for any further orthodontic treatment. According to the intact adjacent teeth, a conservative treatment option was preferred. However, RBB was contraindicated based on deep overbite. Thus, monolithic IPS e.max CAD VRFDPs were selected as the treatment of choice.

A female patient, 45-years-old, sought treatment concerning her anterior mandibular teeth. Intraorally, the prominent features were 3mm open bite, mild teeth discoloration, spacing in anterior mandibular incisors, vertically displaced right lateral incisor with grade II mobility, which was confirmed by alveolar bone loss and inappropriate crown-root ratio in the subsequent radiographic examination. The tooth was not savable due to the chronic localized periodontitis. After discussing the treatment options, the patient consented to a two-phase comprehensive treatment plan for the anterior teeth. The first phase involved extraction of the hopeless tooth. The patient's extracted tooth was modified into an ovate pontic and used as a temporary restoration for two months. The second phase was comprised of space management and replacement of the missing tooth. The previous periodontal problem had resulted in inadequate bone volume in the edentulous space. Due to the costs and longevity of the treatment duration, advanced surgical corrections for an implant placement were rejected. Thus, a tooth-supported restoration was considered as the alternative treatment. According to the interdental spacing in the anterior lower teeth, the mesiodistal width of the edentulous space was beyond the anatomic dimensions of a mandibular lateral incisor, and a lingual RBB could lead to an unesthetic appearance. Based on these limitations, a layered lithium disilicate press VRFDP for the right lateral incisor and veneers on left incisors was planned.

A 21-years-old female with a concern about her smile in the upper arch, including a missing right lateral incisor, peg-shaped left lateral incisor, midline diastema, and wear in central incisors, presented for treatment (Figure 1). To overcome the unesthetic appearance and functional rehabilitation of the anterior teeth, veneer restoration was deemed necessary. Despite the patient's demand for conservative fixed treatment of the edentulous area, she was reluctant to undergo any surgical procedure. Due to the rejection of surgical intervention, RBB was the next available conservative option for the missing tooth replacement. However, this treatment option required additional preparation of the abutment teeth on the palatal surface. To avoid preparation of the maxillary right canine and central incisor on both labial and palatal surfaces, decision was made to place the pontic by means of veneer retainers.

Figure 1. Worn central incisors and peg-shaped lateral (preoperative view)

Prior to treatment, diagnostic casts were obtained and mounted using facebow and interarch record on a semi-adjustable articulator (Artex CPR Semi-adjustable articulator, Amann Girrbach, Koblach, Austria). The diagnostic wax-up was digitally designed and used to fabricate a guide for the mock-up. Canine protected occlusion was planned as the occlusal scheme in case 1 and 3. Since case 2 had no concern about her anterior open bite no occlusal modification was considered. Once the diagnostic restorations were performed, occlusion was adjusted and patients' approval for the esthetic result was gained. Subsequently, a silicon index was made as the preparation guide. Due to the outward direction of the occlusal forces in the maxilla, an onlay preparation was considered for the maxillary

first premolar in case 1 (Figure 2). Veneer-restored abutments were prepared in butt-joint design with 2 mm incisal and 0.5-1 mm labial reduction. In case 2 only minor incisal modification was performed to remove sharpness. To provide an adequate bucco-lingual dimension of connectors the preparation extended to the proximo-lingual line angles adjacent to the edentulous areas. Definitive casts were obtained from a two-stage silicone impression. Stereolithographic (STL) data were acquired by a table-top scanner (Laboratory scanner D700, 3Shape, Copenhagen, Denmark.). Following this stage, restorations were digitally designed in full-contour configuration. For the heat-pressed layered restorations, the cut-back process performed in reference to manufacturer's guideline to keep 0.8mm of minimum thickness for the bridge framework. To fabricate the monolithic VRFDPs, a five-axis milling machine (Ceramill Motion2 milling machine, Amann Girrbach, Koblach, Austria) milled the restorations out of IPS e.max CAD blocks (IPS e.max CAD, Ivoclare Vivadent, Schaan, Liechtenstein). The CAD-CAM generated wax patterns for the substructures of IPS e.max press (IPS e.max press, Ivoclare Vivadent, Schaan, Liechtenstein) VRFDPs and veneers were invested and after wax burn-out the selected ingot was pressed. Finally, the framework was layered to obtain the final restorations.

Figure 2. Veneer and onlay preparation for VRFDP replacement of the 1st premolar in maxilla

Following the confirmation of the marginal fit, occlusion, and optical properties in a trial insertion, isolation was applied and the restorations were delivered using a light polymerizing resin cement (Light-cured resin cement, CHOICE^{TM} 2, Bisco, IL, USA) (Figure 3).

Figure 3. Final appearance of the VRFDPs in position immediately after cementation

After completion of the treatment patients were followed-up through five years. The teeth and periodontal health, as well as the restorations, were maintained in yearly recalls. Additionally, patients were satisfied with the treatment results.

An electronic search of the literature was conducted through PubMed using the following terms: (((laminate retained fixed bridge) OR (Fixed [All Fields] AND ("dental prosthesis"[MeSH Terms])) OR ("dental veneers"[MeSH Terms] OR "dental veneers"[All Fields])) AND "single tooth replacement". The searches were confined to case report/series articles with available full-text written in English and published until December 2020. The literature search was further supplemented by manual searching of the bibliographies of the included studies. Eight articles were identified. After removing the duplicated article with same case being reported in different years (11), seven articles (12-18) were included, among which four reported a duration of follow-up (Table 1) (14-16, 18).

Table 1. Case reports of VRFDP for treatment of single missing tooth

Author	Number of		Replaced missing teeth	Restorative material	Follow-up duration	Complication
	Restorations	Units				
Ibsen et al, 1986(15)	1	3	Max* lateral incisor	Feldspathic porcelain	One year follow-up	Fracture of mesial retainer during cementation
Sonntag, 1988(12)	2	3	Max lateral incisors	Feldspathic porcelain	NR †	NR
Schaffer, 1988(13)	1	3	Max central incisor	Feldspathic porcelain	NR	NR
Cohen et al, 1990(17)	3	3	Max first premolar, lateral, and canine	Feldspathic porcelain	NR	NR
Reid, 1990(14)	1 1	3 2	Max lateral incisors	Feldspathic porcelain	18-36 months	Failure in pontics due to trauma. Fracture in interproximal area.
Denissen et al, 1993(16)	7 3 2	3 4 6	Central incisors, lateral incisors, canines	Feldspathic porcelain	Five years	Marginal deterioration of the veneers. Restoration fracture. Compromised periodontal health.
Bissasu et al, 2014(18)	2	3	Max lateral incisors	Lithium disilicate	18 months	Nill

*Max: Maxillary, † NR: Not reported

4. Discussion

The loss of a tooth especially in the esthetic zone is a traumatic occasion for the patients and additional insult is created if healthy teeth adjacent to the missing tooth must be damaged. It has been shown that damaging the neighboring teeth was among the most important factors affecting the choice of treatment (3, 19). Consistent with this finding, all the patients in the present report were reluctant for aggressive damage to their sound vital teeth. A search of the literature identified seven reports that described cases treated with the VRFDP (12-18). Careful patient selection and occlusal adjustment, as well as adequate preparation design for a durable restoration, have been shown as critical parameters for a successful treatment (14, 16). Although high-stress conditions were avoided, restoration fracture has been reported in all early publications with a duration of follow-up (14-16). This consequence to some extent, could be associated with the low-strength feldspathic glass-ceramic as the restorative material.

The present report used CAD-CAM lithium disilicate VRFDP in anterior and premolar area in both maxilla and mandible with no mechanical or biological complication through five years of follow-up. The flexural strength of the lithium disilicate glass ceramic is about four times more than feldspathic porcelain. Moreover, it has been shown that the difference in the flexural resistance of IPS e.max Press and IPS e.max CAD is not significant and other parameters should be considered as the decisive criteria to choose one in a clinical situation (20).

Preservation of the tooth structure is another critical parameter for the longevity of the restoration and teeth. A study has reported that butt-joint incisal reduction is associated with greater fracture resistance in the veneered tooth than a tooth with an incisal reduction combined with palatal chamfer (21). Further, in the present report a precise occlusion was adjusted with the opposing teeth to distribute the centric and eccentric loads in a way to avoid high stresses in the pontic area.

Implementation of the digital protocols in the design and fabrication process of the restoration provided the advantages of precise control over the restorations' dimension, occlusal contacts, and planning a conservative preparation. The fabrication guideline for IPS e.max fixed bridges recommends 16mm^2 for the connector's dimension. To follow this protocol, when anatomical limitation exists for a broad buccolingual width compensation should be executed by an increase in occlusogingival height. As the guideline indicates, the ratio of height to width should be greater than one. Such dimensional optimization is streamlined by digital technology.

5. Conclusions

Given the high number of variables affecting treatment decisions, a universally effective solution does not exist for single tooth replacement. Clinicians should establish a balance in the esthetic needs of the patient, strength of the restoration, and protection of the remaining teeth. Such parameters must not be seen in isolation, but in combination with the patient's wishes and the capabilities of the treatment provider. This clinical report described the application of the new technologies and modern ceramics for VRFDP in single tooth replacement when specific limiting factors for more predictable options exist. This treatment modality can benefit from further controlled studies to justify clinical parameters such as the optimum preparation design.

Ethical Considerations

This study was approved by the research ethics committee of Tehran University of Medical Sciences (IR.TUMS.MEDICINE.REC.1399.806)

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Authors' Contributions

Vanya Rasaie: Conceptualization, Writing - Original Draft **Marzieh Alikhasi:** Resources, Supervision, Visualization **Yasamin Babaee Hemmati:** Writing - Review & Editing, Methodology **Mehran Falahchai:** Conceptualization, Project administration

Conflict of Interests

The authors declare no conflict of interest**.**

Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request. Moreover, the datasets supporting the conclusions of this article are included within the article.

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